Visible Language

The journal of interface, experience, and communication design research

Volume 59 Number 1

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Published continuously since 1967

Figure 1. Preliminary design with integrated palette of buttons with icons in the top area.

inside

front

cover

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The **Visible Language Consortium** is a collaboration among three institutions — through the School of Design at University of Leeds (UK), the Ullman School of Design at University of Cincinnati (USA), and the College of Design at North Carolina State University (USA) — from which the **editorial board** of *Visible Language* is composed:

2024

eing a urnal Editor: ut with the old. with the new!

Mike Zender

2019

Figure 12.

Participant opinion regarding the 'New' Terror Threat Levels system infographic.

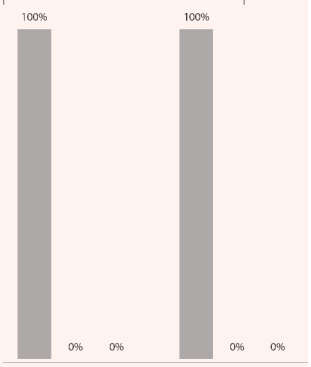
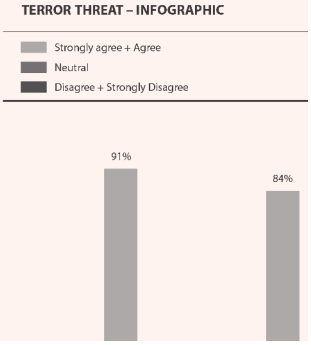


Figure 13.

Participant opinion regarding the 'New' Emergency Action Plan infographic.



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original Visible Language *was about writing and ling. The evolved* Visible Language *will be about ng, experiencing and gaining meaning from it.*

Specifically, *Visible Language* will be about publishing research and stimulating discourse to create knowledge of how designers make what people see, which informs what people know and do.

We trust *Visible Language* will continue to be quirky and broadly inclusive. It will welcome research from all design disciplines and points of view. But it will also seek to advance the quality and quantity of design research, from defining how design research is and is not like research in other fields, to identifying best research methods and apt standards of rigor.

This journal has been around for nearly 50 years. A transition is a good time to ask 'why.' Why is *Visible Language* around? Because it is self-evident that we are all surrounded by, immersed in visible language. Because the majority of our cerebral cortex processes visual information. Because designers who use visible language every day have so little explicit knowledge to guide their work. Because it is tremendously fun to learn and grow in community with colleagues who stimulate and challenge us through respectful discourse. With the explosion of technology putting visual language in the palm of our hands, *Visible Language* is more important today than 47 years ago when Merald Wrolstad founded it. Welcome to the next 46 years of *Visible Language*!

2016

2013

continued on page 109 →

EDITORIAL

Visible Language

Volume 59 Number 1

In with the New!

Maria dos Santos Lonsdale

School of Design, University of Leeds, Leeds, UK (M.Lonsdale[at]leeds.ac.uk)

"Out with the old. In with the new!" — this is how Mike Zender finished the editorial of the last issue of volume 58 and how I start the editorial for the first issue of volume 59. Issue 59.1 (2025) marks the start of the new Visible Language Consortium of three universities: University of Leeds (UoL in the UK), North Carolina State University (NCSU in the US), and University of Cincinnati (UC in the US).

It is my true honor to represent the first of the three universities to host *Visible Language* for three years and hold the title of editor-in-chief while we work together, and on equal terms, with two fantastic editors: Mike Zender and Matthew Peterson.

Since 1967, three *Visible Language* editors have established very solid foundations for the journal and developed it to be one of the most prestigious journals in the area of communication design. As tempted as I am to list them all and praise their great efforts and contribution, I will make Sharon Helmer Poggenpohl's words in her article at the end of this issue — "*Visible Language* Evolves" — my words. Sharon served as *Visible Language*'s editor and publisher for as many as 26 years (up to 2013) and the way she tells us the story of *Visible Language* is precious and one that I could never tell as well.

Instead, I am going to take you "behind the curtain" of the new Visible Language Consortium and give you a sneak peek of what we are doing in terms of "Out with the old. In with the new!"

Governance and structure. As shown in Figure 1, we strategize, govern, and operate through an executive board and an editorial board. The executive board convenes

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North Carolina State University (USA)

as often as needed, and the editorial board meets every four weeks with a defined agenda and agrees on a set of clear actions to implement in the four weeks that follow. Our pioneering approach as a consortium of three universities has also led to a well-structured governance that allows for *resilience, empowerment,* and *succession.*

Resilience because *Visible Language* is no longer dependent on one editor or a very small editorial board, and therefore there is no risk of *Visible Language* ever having to pause or delay operations due to a reduced workforce. Having said that, Mike Zender's resilience and ability to keep the journal on track almost single-handedly for over a decade was incredible and unmatched.

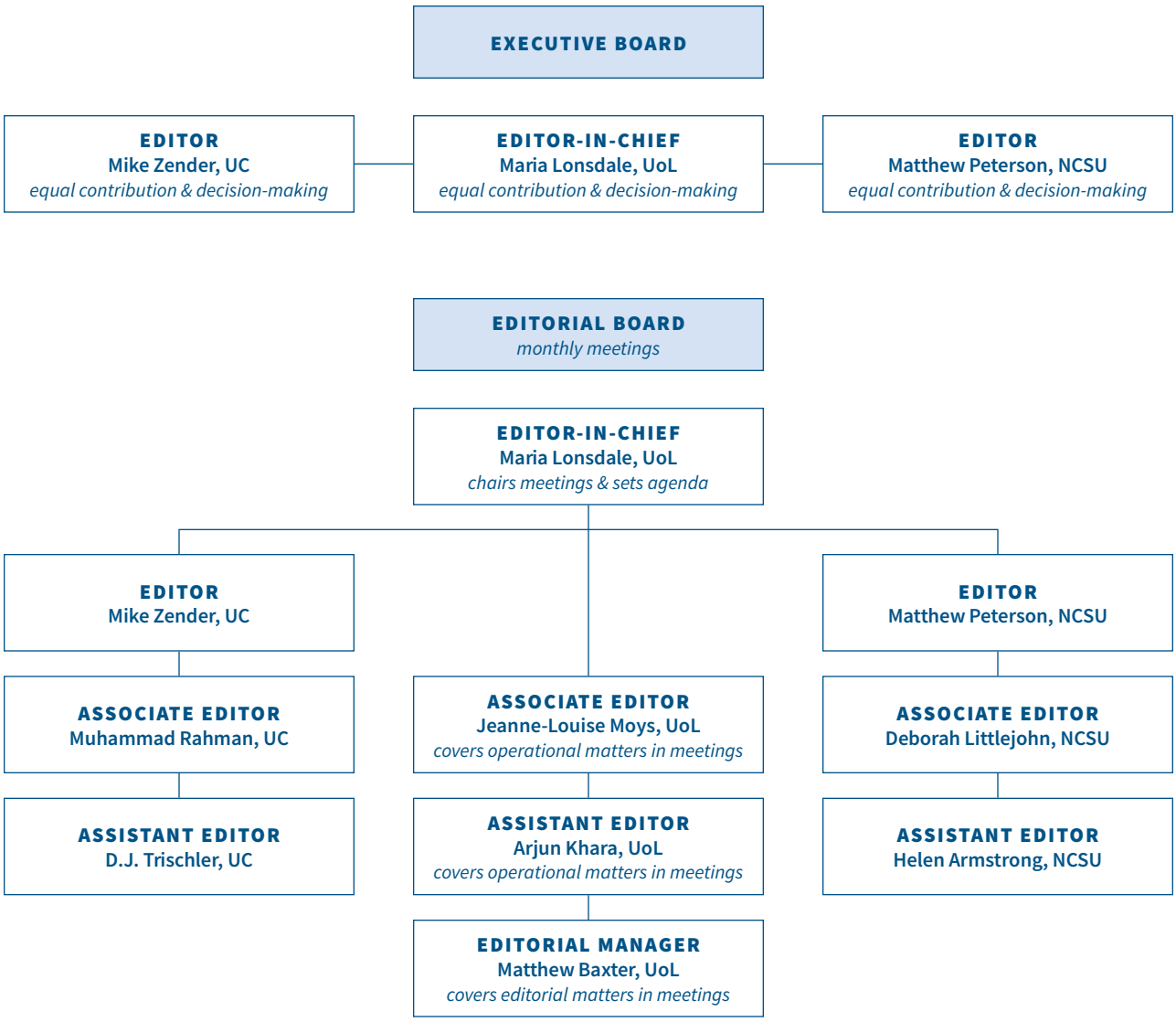

Figure 1. *Visible Language* governance and structure — January 2025 to December 2027.

Empowerment because we established a structure where each university in the consortium has a clear line of roles, where more senior roles (editors) mentor and empower other roles in the chain of command. This then equips those with roles beyond editor to contribute to strategy and decision-making, act independently when actioning certain tasks, and develop and grow in their *Visible Language* role but also academic career.

Succession because by mentoring and empowering roles beyond editor in a chain of succession (associate editor followed by assistant editor) means that we are developing the next generation of editors for *Visible Language*. That next generation will keep the journal fresh and at the forefront of publishing in the area of communication design and beyond. The way this works is as follows. Eventually I will step aside to give way to my current associate editor at the University of Leeds to become the editor for our university; Matthew Peterson will do the same for NCSU after his three years as editor-in-chief between January 2028 and December 2030; as will Mike Zender in the future.

Workforce. Following from the above, our editorial board includes academics at all stages of the academic career, i.e., senior, mid-career, and early career. Moreover, while the three consortium universities are based in the UK and US, our editorial board includes academics who are native from countries in four different continents. This breadth in terms of cultural backgrounds, together with a range of career stages, informs *Visible Language* on how to be a truly open access journal, i.e., accessible to and catering for all globally.

Beyond the *Visible Language* editorial board, we also work with students and industry creatives to bring an extra layer of knowledge and perspective. For example, we are currently working with Justin Pokorski, a Master of Design student at the University of Cincinnati, to develop a *Visible Language* archive. We are also working with a young team of communication, digital, and UX/UI designers at PACE (Professional Academy for Creative Enterprise) in the School of Design at the University of Leeds.

Focus. We have been discussing and looking closely at what *Visible Language*'s focus should be from 2025, which will continue to evolve and adapt as the field of design grows and changes. After various and careful discussions, our consensus and decision is that *Visible Language* is the journal of research in interface, experience, and communication design. *Visible Language* impacts academic professionals, industry professionals, and students by supporting knowledge generation in and adjacent to design. The journal advocates the teaching, research, and practice of visual communication design to enhance the human experience. *Visible Language* balances artfulness with science, innovation with respect for human patterns of use, evidence-based research with intuitive exploration, and technology with humanity.

Innovation and growth. While the new consortium has only been officially in place from January 2025, we have been very proactive and ambitious in terms of where we want to take *Visible Language* and our readers. Various actions/initiatives have taken place already, some have started and are in development, and others will start in the next few months. Here are some examples.

- Editors Mike Zender (University of Cincinnati) and Matthew Peterson (North Carolina State University) visited Editor-in-Chief Maria Lonsdale at the University of Leeds in 2024 to forge the new Visible Language Consortium collaboration.
- We are launching this first issue of volume 59 under the new consortium through our new *Visible Language* open access model. We worked to secure the institutional support necessary to cover the irreducible costs of publication beyond our volunteer efforts — to ensure that neither readers nor authors incur expenses.
- We designed a new *Visible Language* logo that went through various stages of development and iteration. We have recently launched a bespoke *Visible Language* website.* We also have a new design for the article PDFs that can be downloaded through *Visible Language*'s open access, which prioritizes integration in broader scholarship beyond design through stylistic decisions and typographic features. The design will continue to evolve through future issues in collaboration between the *Visible Language* editorial board and the PACE Creative Team. We will also have presence on various social media platforms.
- We are currently in the process of developing a *Visible Language* next generation archive — Viz Archive — with UC's Master of Design student Justin Pokorski. This is a unique and innovative approach in an academic journal. Its design is going through various stages of development, testing, and iteration to make sure it caters to the needs of all of our readers: academics, practitioners, and students.
- The Visible Language Consortium is committed to rigor and relevance in design scholarship. Towards that end, the journal is now Scopus-indexed. This is of great relevance to academics and researchers in countries such as the UK, where our research outputs are assessed through the Research Excellence Framework (REF).
- We are also being more proactive in terms of reaching our audience in person. The first of these activities was to attend and have journal representation at the ATypI Copenhagen Conference in April 2025.

* https://www.visible-language.org/journal/

Ethos. The only thing we will not change is our *ethos* as a journal. As an editorial board we will continue to operate in a collaborative, collegial, respectful, and kind manner, both internally as well as externally with our authors, reviewers, and readers. We will be an editorial board fully dedicated to *Visible Language* and hands-on to make sure *Visible Language* continues to be one of the most prestigious design journals, for the greater good of our design discipline and ultimately of its contributors and readers.

With this in mind, volume 59 focuses on our three key audiences and each of the volume's three issues is dedicated to them. Issue 59.1 — **Past** — *Visible Language* invited prestigious academics and researchers who have been long-term contributors to the journal and to the field of communication design. Each was asked to share their perspective on design research informed by their years of experience and what their thinking is at this stage in their career. Without wanting to spoil it, I will only mention who our contributors to issue 59.1 are so that it gives me the opportunity (and on behalf of all three editors) to thank them immensely for their time and contribution. They have all been a delight to work with and we are so honored to start the new era of *Visible Language* sharing their words and insight.

- Nigel Cross: "Making Design Research Visible"
- Meredith Davis: "A Shifting Practice Paradigm Meets a Persistent Curriculum Paradigm"
- Charles Bigelow and Kris Holmes: "Digital Type Challenges"
- Mary Dyson: "Towards Interdisciplinary: Juggling Similarities and Differences"
- Karel van der Waarde and Myra Thiessen: "Nineteen Questions to Evaluate Typographic Research: Chaff and Wheat"
- Sharon Poggenpohl: "*Visible Language* Evolves"

Issue 59.2 — **Present** — *Visible Language* will bring articles written in collaboration with design practitioners and/or focusing on design practice and industry to inform our readers of the current landscape and trends in the field of communication design, especially concerning artificial intelligence in design.

Issue 59.3 — **Future** — *Visible Language* will publish articles generated from collaboration between research design students and their supervisors, who are currently developing the latest research that will be implemented and disseminated in the next few years. As of this writing there is an open call for papers.

This is a time of great excitement for us all on the *Visible Language* editorial board. So much done but so much still to do! Most importantly, we have fully achieved our

number one goal when establishing the consortium — to make *Visible Language* an open access journal for all our loyal readers and to the many new readers we hope will join *Visible Language* from here onwards.

Visible Language is now the design journal that everyone around the world, with no exceptions, can access and enjoy free of charge, publish their research and practice in, also free of charge, and learn from others in order to inform their research, practice, or studies.

Professor Maria dos Santos Lonsdale
University of Leeds, UK
Editor-in-chief of *Visible Language*

INVITED ARTICLE

Making Design Research Visible

Nigel Cross

School of Engineering and Innovation, The Open University, Milton Keynes, UK
(nigel.cross[at]open.ac.uk)

Abstract: Design research now has an established history extending over more than 60 years. The current robust state of the field indicates that there has been real development and consolidation, including the establishment of academic journals. Most significantly, design is now recognized as an academic discipline. Disciplines need good journals in order to flourish — research has to be made visible.

Keywords: design discipline; design research

In the small, English-speaking North Atlantic region of the world, the starting points for our current conceptions of design research lay in the early conferences and societies that appeared in the 1960s. (In other parts of the world, some were a bit earlier, some a bit later.) The Conference on Design Methods in London in 1962 led to the founding of the Design Research Society (DRS) in the UK and the Design Methods Group (DMG) in the USA in 1966. This estimable journal, *Visible Language,* pioneered the publishing of research in communication design in 1967 (as *The Journal of Typographic Research*), around the same time as the DMG began its modest *Newsletter* but a full 12 years before the DRS journal *Design Studies*. A common feature of these design research-related conferencing and publishing initiatives of the 1960s was, firstly, the perception of design as a process, i.e., a cognitive skill rather than an intuitive talent, and secondly, the perception of design as an academic subject, i.e., knowledge-based, beyond being learned just as a practical art, and therefore capable of being taught, studied and researched alongside other academic subjects. These two perceptions led to their combining into an overall perception of design as an academic discipline.

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After all these 60+ years of design research, the achievements may seem to be fairly modest. But younger design researchers today might find it difficult to imagine their field as it was in the 1960s as the new approaches and attitudes to design began to appear. There were none of the journals we now have; no design research conferences or societies; no postgraduate and certainly no PhD research programs in design; no concept of design as a discipline.

I believe that this concept of design as a discipline is the most significant outcome of those very early developments. Design graduates are now better educated, more self-aware about designing and the design process, how to be a designer and the contribution designers make to society. Going beyond that, developing design as a discipline has made it possible for design to interact on an equal basis with many other disciplines, from computer science to cognitive science, anthropology to psychology, sociology to philosophy, all leading to positive feedback loops that now make design research very different from its early starting points.

Disciplines begin to emerge when a few pioneers start to recognize some common interests that suggest possibilities for new approaches, methods and interpretations. They usually develop from within established university departments and traditional "parent" disciplines. That is why emergent disciplines can initially create frictions and attract criticisms, can be difficult and challenging, and can take time to become established. We can recognize all these features in the history of design research.

Emerging disciplines are characterized by their initial novelty and the challenges they face, with rather slow early progress. A period of more rapid growth follows, marked by increases in publications, with new journals and outlets (especially conferences) for presentation, discussion and dissemination of new research. These developments eventually lead to influence within the established parent disciplines and both internal and external recognition of the impact of the new research. Eventually, the emergent discipline establishes its own internal coherence that connects and combines the research methods and outcomes, and the viewpoints that arise, all of which enables connections with, and influence upon, other disciplines and more distant practices. Again, we see this connecting process in the early and the more recent history of design research and the foundations of the discipline of design. We have also seen the emergence of design out of parent, domain-specific departments into self-standing interdisciplinary and transdisciplinary departments, schools, faculties and even colleges of design.

The current state of design research is the outcome of this more than 60 years of growth and development. The major, established and widely-recognized disciplines of study may have much more substantial histories than that, but they all began somewhere and

somehow: they all arose from modest beginnings and took many decades to mature. Design research is no different.

One thing that is clear from the history of disciplines is that they need communication to foster, aid and cement their emergence and growth. Conferences have been important in establishing early communication, but the classic form of mature communication, of course, is the academic journal, which not only publishes communications and disseminates new knowledge but also constructs and curates the field and sets a discipline's standards. It is this responsibility that is undertaken so willingly and conscientiously by journal editors and their bodies of reviewers.

A few years ago, I signed off my editorship of the journal *Design Studies* with a special issue on the theme of "Design as a Discipline" (volume 65, November 2019), which had been a fundamental starting point for the journal, 40 years before. Looking over the set of diverse and erudite papers in the special issue on the state of design as a discipline, and reflecting on the 40-year history they conveyed, I asked in the issue's editorial "what do we see?," and responded:

> What emerges is a strong sense of academic achievement and the establishment of a genuine discipline of design. There are some caveats and concerns, but the overarching message is very positive. We see the identification, articulation and clarification of the discipline's knowledge bases, underlying skill-sets and values. We see both diverse and quite focused research programmes that have been pursued with rigour and imagination. Overall, there has been a movement away from early, technically-orientated approaches to reforming the methods and processes of design, towards a comprehension of design as a cognitive and social, creative reflective practice. There are still the same objectives related to improving design activity and design outcomes, but more by understanding and developing human design skills, rather than replacing them with artificial rationality. (Cross, 2019, p. 5)

Unfortunately, not because of any weakness in the design research community but because of a publisher's disruptive actions, the future role of *Design Studies* is now uncertain (DRS, 2023). But *Design Studies* has not been the only journal responsible for the development of that encouraging view I gave above, and the very presence of so many other journals reinforces the view of a meaningful discipline having been established. The key point is that the underlying research base of a discipline has to be made visible, it has to be communicated, i.e., we have to publish, and that publishing has to embody, reflect and develop the standards of the discipline.

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Author

Nigel Cross is Emeritus Professor of Design Studies, The Open University, UK. He has considerable experience as a design teacher and an international reputation as a design researcher through books such as *Analysing Design Activity, Designerly Ways of Knowing,* and *Design Thinking: Understanding How Designers Think and Work.* He was a founding editor of the journal *Design Studies* in 1979 and its editor-in-chief from 1984 to 2017.

INVITED ARTICLE

A Shifting Practice Paradigm Meets a Persistent Curriculum Paradigm

Meredith Davis

College of Design, North Carolina State University, Raleigh, NC, USA (mjdavis[at]ncsu.edu)

Abstract: There is little debate that the demands of professional design practice and design research today are significantly different from the 20th century when modern graphic and industrial design programs first entered liberal arts colleges and universities. Currently, there is much academic discourse regarding the new outcomes for which today's designers are accountable under an ongoing shift in the nature of professional practice. However, design cannot fully address a new practice paradigm if design educators do not also rethink a persistent curriculum paradigm from the industrial era. This article argues that new course outlines alone are insufficient in overcoming the implicit messages about design practice delivered through the historical structure and pedagogy of college and university design programs.

Keywords: colleges and universities; design curriculum; design education; design history

1. Introduction

Educational psychologist and reformer Lee Shulman said, "If you want to understand a profession, study its nurseries" (2005, p. 52, paraphrasing Erik Erikson).

There is little debate that the demands of professional design practice and design research today are significantly different from the 20th century when modern graphic and industrial design programs first entered liberal arts colleges and universities. There is no shortage of current academic discourse regarding the new outcomes for which today's designers are now accountable. However, design cannot fully address a new *practice paradigm* if design educators do not also rethink a persistent *curriculum*

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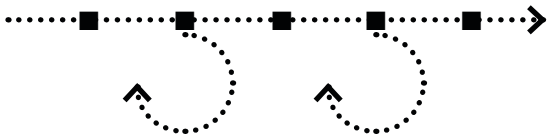

Figure 1. Simple causal chain with action taken at a few leverage points.

paradigm from the industrial era. The following discussion argues that new course outlines alone are insufficient in overcoming the implicit messages about design practice delivered through the historical structure and pedagogy of college and university design programs.

2. A Little History

A confluence of forces in the early decades of the 20th century shaped the academic environment for the modern professions of graphic and industrial design. Industry scaled up production to meet the demands of a growing consumer culture. Higher education continued its professionalization of college curricula. And modernism offered a strategy for addressing the problems created by industrialization, urbanization, and globalization with design as an agent of change.

The Second Industrial Revolution set the agenda for design practice. A "design problem" mirrored the assembly line: a linear causal chain that converted capital, raw materials, energy, and labor into consumer messages, products, and spaces (Figure 1). Designers took action at a few leverage points to resolve some perceived misfit between the form of physical artifacts and their production or use. An emphasis on appearance and craft explored the expressive potential of new modern materials. The industrial goal was optimization: efficiency in producing almost-perfect, consumer-facing editions that were sometimes separated by years. Management applied a top-down waterfall process of decision-making, approving work in stages and passing it to the next group of experts. Designers saw the consumer experience as "universal" and made intuitive decisions they considered to be in the best interest of the people who used what they made.

The turn of the century also saw a continuing professionalization of higher education that shifted college and university curriculum purposes from students' mental and moral development to solving the practical problems of modern life. Fields previously located in freestanding professional schools — business, law, and medicine, for example — moved the preparation of future practitioners to liberal arts colleges and universities. Some fields made this transition in steps, starting with informal apprenticeships and later developing professional curricula, often at the graduate level (Goldin & Katz, 1999). Faculty became *academic professionals* who also serve the research functions of

their disciplines and institutions. Consistent with the operations approach deployed by industry, professional design, engineering, and management curricula entered these academic institutions under separate administrative units, which would later present curricular and research challenges in the overlapping work of the information age.

Throughout the 20th century, a number of these new university disciplines systematically studied problem-solving curriculum and pedagogy. Harvard University had a longstanding interest in case studies under which students framed the problem at hand, assumed decision-making roles, and justified the rationality of their decisions (Schmidt, 2012). Applied at the *end* of the curriculum, the case-study approach asserted that practical insights came only *after* students acquired disciplinary knowledge. Contrasting investigations at McMaster University in Ontario, Canada, argued for students acquiring necessary knowledge *across* the course of working on applied problems. Although McMaster research showed that medical students and practicing physicians were equally good at reasoning, practitioners' diagnoses were simply better. Mastering a reasoning *process* ultimately mattered less than mastering *concepts* (Burrows & Tamblyn, 1980). Maastricht University in the Netherlands studied problems as a function of *context.* A problem was viewed as a set of phenomena or events that "could be described in terms of their underlying principles, processes, laws, or mechanisms" (Schmidt, 1983, p. 28). The student's task was not action but mental models or theories that explained phenomena. In all of these examples, students collaborated in actively framing problems.

Similarly, industrialists founded independent professional schools to meet demands for a modern design workforce. Unlike other professions, however, the field continued to support these freestanding, single-discipline schools as a pathway to practice, even as liberal arts colleges and universities added graphic and industrial design study to their fine arts curricula. Dual curricular offerings continue today, and depending on the country, they determine the requirements, duration of study, and whether undergraduate students earn a diploma or bachelor's degree.

In both institutional contexts, design duplicated its trade-oriented training model, with the Bauhaus having an outsized influence in furthering a vocational approach. The school referred to students as *apprentices* and *journeymen*, a reflection of the centuries-old guilds and ateliers that socialized young men in craft-based trades. Learning by doing under the tutelage of a *master* involved little theory; *problems* resided in the application of perceptual phenomena and the nature of materials. Although the Bauhaus intent was to align design study with higher education interest in practical education and the industrial goals of its sponsors, relatively few Bauhaus products were commercially produced in their own time. In the school's move from Weimar to the industrial town of Dessau, director Walter Gropius had to insist that work in the joinery studio respond

to a list of consumer preferences (for example, an angled back in chair design; Droste, 2006). Laszlo Moholy-Nagy lost funding for the New Bauhaus in Chicago following negative reviews of student work, including a *Time* article calling it "an exhibition of bewildering nameless objects" (Sisson, 2019). And by the time Ludwig Mies van der Rohe established an architecture program at Armour Institute in Chicago, the curriculum no longer required applied building experiences. Critic Tony Fry described the output of the Bauhaus as mostly "published representations of industrial work…unproducible under mass manufacturing and lacking consumer appeal" (Fry, 1999, p. 158).

Despite little evidence that the Bauhaus truly served the problem-solving needs of industry, the modernist curriculum model became the dominant approach to design education by the middle of the century. It spread through the immigration of Bauhaus faculty and applications at a few high-profile institutions. The curriculum was easy to replicate and could be taught by existing fine arts faculty. The preliminary course also offered a unified arts approach and simple language of form — the "elements and principles of design" — which K-12 art educators found appropriate for pre-college art education. For much of the 20th century, "design" was synonymous with "abstraction," rather than a profession, for many secondary students.

Graduates of 20th-century college design programs also contributed to the worldwide proliferation of a modern design monoculture that replaced indigenous forms and practices. Under an economic and technological global hierarchy, there were centers of innovation, places that served centers of innovation, and places perceived as having little hope of overcoming their historical and local conditions (Florida, 2005). Modern design concealed such differences under a singular, rational expression of social progress. This presumption of universality encouraged institutions to reproduce modern design curricula, even under culturally and economically diverse circumstances. Embracing modernism would later result in 21st century concern for issues of design colonization.

Maintaining and perpetuating a mostly vocational training model in two types of institutions — single-discipline professional schools and multi-purpose colleges and universities — likely delayed the evolution of design in areas normally characteristic of professions but not trades. The scholarly study of design methods did not emerge until the 1960s.* A comprehensive history of graphic design was not published until 1983 and followed an art historical canon with few references to parallel developments in commerce, management, technology, and non-Western cultures (Meggs, 1983). Graphic and industrial design often remain *subdisciplines* of art in many institutions, while new design offerings and research develop in other non-art units (in user experi-

* The Conference on Design Methods took place in September 1962 at the Department of Aeronautics, Imperial College in London, UK.

ence, service design, data visualization, and transition design, for example). Unlike other fields, many master's programs in design still require independent study aimed at personal growth in the fine arts tradition, not explicit instruction in a consensus-built body of knowledge preliminary to more advanced work in the field.

In particular, the development of a design research culture lagged far behind other fields, even as the 20th century professionalization of higher education prompted the development of the modern *research university*. Doctoral study in design was not available until the 1990s and there is still considerable debate regarding the differences between practice-based and research-based PhDs, as well as the appropriateness of graduation submissions (artifacts versus dissertations) as "knowledge" (Davis et al., 2023b). The standards applied to design faculty scholarship often vary widely from those used by the institution to evaluate faculty work in other disciplines, subsequently denying designers access to some types of research funding and partnerships.

This history would shape a longstanding approach to design curricula and pedagogy that persists today, despite the formidable challenges of the Information Revolution.

3. Paradigm and Pedagogy

Historian Thomas Kuhn wrote about paradigm shifts in his 1962 book, *The Structure of Scientific Revolutions.* He defined a paradigm as the established theories that a field agrees address the most acute problems of the time. Kuhn (1962) characterized these theories as having been sufficiently novel at one time to pull advocates away from competing perspectives and become the basis of fact (p. 24). The paradigm offers fundamental principles and standards that guide ongoing practice and succeeds by continually revealing a family resemblance among the problems to which it is applied (pp. 10, 46). It is a filter that determines what is and what is not a problem in the field.

A shift occurs when anomalies illustrate the inadequacies of existing theories to account for new problems. Kuhn observed that the field first responds by relaxing or stretching threshold criteria to make problems appear to fit the established paradigm. For example, practitioners extended design thinking — a step-by-step approach first developed for the design of human-centered artifacts — to problems ranging from business to government and K-12 education. In other cases, advocates of the established paradigm argue that aberrant problems are the domain of other fields. Advances in the data economy, for instance, raise such issues regarding where professional responsibilities for the design of sociotechnical systems reside. And there is ongoing debate regarding whether designers or ethnographers should lead user-centered research in companies.

As anomalies increase, however, they erode the standards of the existing paradigm and require a new language, concepts, and procedures (p. 55). Kuhn classified the remaining work of the field as *puzzle solving*, which simply adds diversity to an inventory of successful applications under problems already known to have solutions (p. 36). He described the new paradigm as calling for a *revolution* in disciplinary knowledge, not an *evolution* of revisionary adjustments or additions to the scope of an existing paradigm.

There is little disagreement that design practice is in the midst of an ongoing paradigm shift that began with computing in the middle of the 20th century and expanded under more recent design responsibilities for environmental and social outcomes. Artificial intelligence also presents new challenges for which many designers are unprepared. At the same time, however, the curriculum paradigm and signature pedagogy that underpin professional design education owe more to industrial-era design practice than to the work of this century.

Stanford education professor Elliot Eisner defined a curriculum paradigm as a theory of learning that determines:

- The consistent purpose of study for which the curriculum is designed;
- The kinds of knowledge the program values;
- What it means for learning and how to assess it; and
- The roles faculty and students play in the learning process (Eisner, 1985).

While design faculty discuss new content intended to make college curricula more relevant to current practice, there is less evidence that they seek consensus for a corresponding theory of learning. Curriculum development today typically involves new subject matter packaged as course outlines. Because the political environment and glacial approval processes of higher education make it easier to invent or change courses than to invent or change curriculum, design faculty often add this new content to an existing program of study — a *curriculum by accrual* approach — rather than rethink the paradigmatic principles and practices on which the traditional curriculum is based.

The *surface structure* of design's persistent signature pedagogy — educator Lee Shulman's (2005) term for the operational aspects of instruction — reflects its industrial-era intent (Figure 2). Beginning undergraduate studies typically isolate perceptual principles and material exploration, consistent with the historical role of design as appearance and craft. The curriculum usually defines upper-level courses by medium or artifact, congruent with specializations in fine arts and the industrial mass production of tangible messages, products, and spaces. All students solve a faculty-defined problem and compare solutions in the industrial spirit of top-down, waterfall management and optimization (finding the "best" answer to a singular challenge). Students work individually and intuitively, offloading consideration for technical feasibility and economic

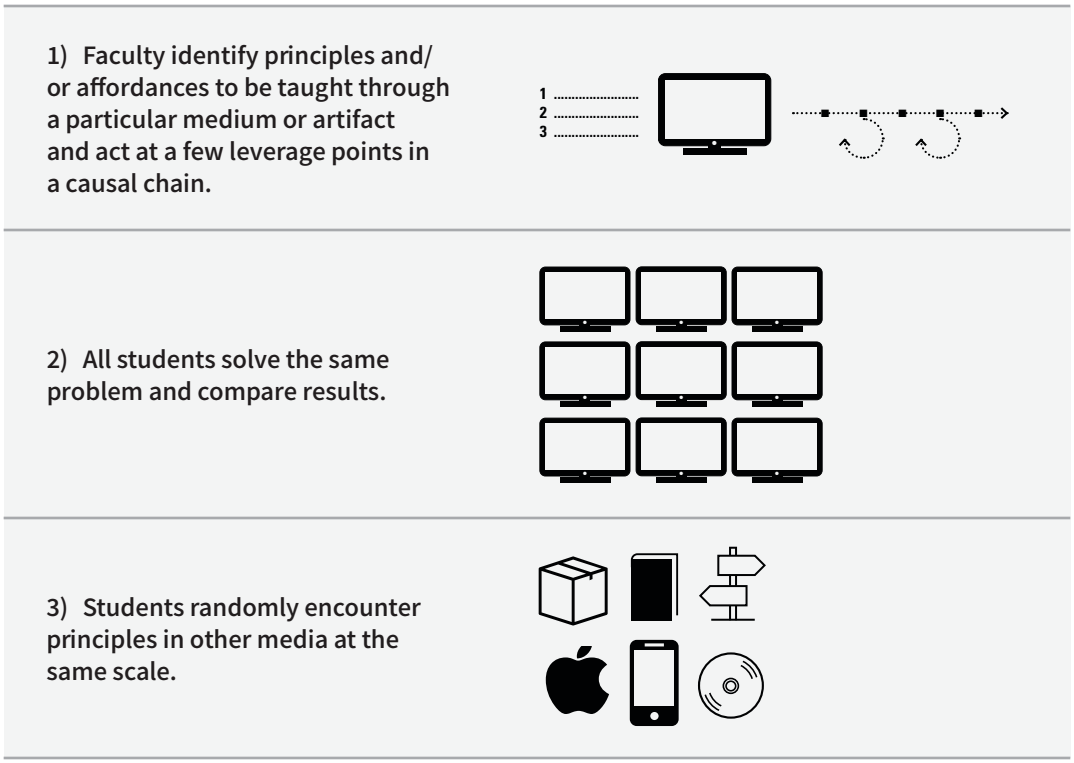

Figure 2. The surface structure of 20th century design pedagogy.

viability to other imagined experts. They spend most of their studio and critique time in refining quickly-narrowed, "almost perfect" solutions that mirror industrial editions. Project research precedes but rarely follows execution and every new assignment begins from scratch.

Further, there are industrial-era implications in what Shulman (2005) described as the *deep* and *implicit structures* of pedagogy and Philip Wesley Jackson (1968) labeled as the *hidden curriculum* — that is, in the unspoken assumptions regarding how an approach to teaching design imparts knowledge and instills in novices the beliefs, values, and attitudes of scholarship and practice in the field.

The traditional curriculum paradigm of design education views complexity primarily as the number of elements, objects, or features to be designed. Typography instruction, for example, progresses from the letter to the word, page, and document. It is more likely that an advanced problem will be the design of a magazine than a system for readers to annotate editorial content. Consistent with industrial-era practice, design students create or adjust the qualities of these elements for short-term outcomes in simple causal chains — *form follows function*. Critiques usually reward solutions that meet observable or known problem constraints, rather than offer alternate conceptions of the situation or that speculate on uncertain or emergent conditions. The design

response to anticipated breakdowns is to redirect people back to an ideal path, rather than to reconsider the conception of the problem under their situated action when design does not perform as expected.

Under a modernist tradition, beginning perceptual studies suggest that the human experience of form is rational and universal and that phenomena studied in isolation will produce similar effects when used in combination and under the influences of context and audience. These early exercises also imply that the design process begins by sketching or the hands-on manipulation of materials in preparation for later courses typically defined by medium or artifact. Accordingly, upper-level projects often foreground particular affordances of the designated medium — solutions in search of relevant problems, rather than problems in search of appropriate media. For example, students in web classes design websites, not service ecologies. Any pattern-finding among problem types usually occurs randomly across the curriculum and individual faculty project authorship.

There is also a curricular implication that problems can be solved under design expertise alone and that designers need not understand the modes of inquiry in other disciplines. Institutions within and outside the European Higher Education Area (EHEA) — the 49 countries under the Bologna agreements developed for cross-national curricular compatibility — differ from other places in the requirements for study outside of design. General education requirements in most North American bachelor's programs, for example, ensure that bachelor's graduates have read and written in a discipline other than their major. These courses, however, are usually *proximate* rather than *integral to* design study, unless the curriculum "double-counts" general education electives as requirements in the design major. Schools in the EHEA have no such requirements at either the undergraduate (diploma or honors bachelor's) or master's levels. As a result, EHEA students advance to practice and doctoral study without preparation beyond studio-based curricula.

4. The Fit of Design Education with Contemporary Practice

If the rhetoric of college websites is accurate, most professional undergraduate design programs intend to educate entry-level designers for practice in their respective areas of specialization. Elliot Eisner (1985) referred to this as a *social adaptation* curriculum paradigm, which "identifies the most salient manpower needs of society and responds to those priorities by preparing students to get ahead under existing workforce conditions" (p. 74). Yet, a paradigm shift in the nature of practice raises questions regarding the match between a 20th century curriculum paradigm and current and emerging positions in design practice. Some even question whether the established types of design practice for which these curricula were designed are still viable.

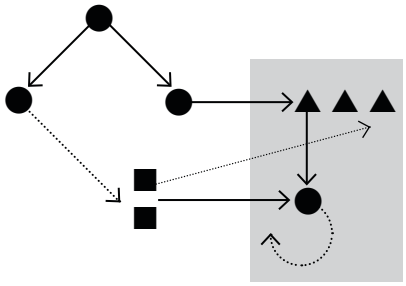

Figure 3. Today's design problems reside in the interactions among complex systems.

The US Bureau of Labor Statistics projects employment in ten-year increments using 29 data points and large sample sizes. The 2019–2029 projections (pre-Covid) show decline in traditional design practices. In particular, the Bureau predicts a combined loss of 14,500 positions in art direction, print and online publishing, and graphic design (brand identity and print collateral) by 2029 (US Bureau of Labor Statistics, 2020). There are more than 2,000 college-level programs in the United States that teach this content at some level. The Bureau expects the much smaller practices of industrial and interior design to lose 1,500 and 3,800 positions, respectively. By contrast, creative work in web and software design will gain 330,400 new positions in the same time period. Based on international input regarding the need for new design competencies, it is likely that the overall trend represented by these American statistics can be found elsewhere.*

The differences between the paradigms that underpin 20th and 21st century practices relate to more than obvious technical competencies suggested by the Bureau's data. The following are less obvious competencies proposed here as representative of the ongoing paradigm shift (Davis & Dubberly, 2023).

- **Changes in employment reflect a shift from designing discrete artifacts to designing systems and services in complex causal networks.** The Information Revolution changed the things designers make, the processes through which they make them, and what they mean in culture. Access often replaces ownership. Even when design solutions call for physical artifacts, they are usually nested within larger ecologies (Figure 3). Understanding and designing the processes through which complex systems transform some form of input into output requires models of how they work, visual stories about actors/elements, their internal behavior and external interactions, and likely effects under dynamic conditions.

* In 2021, The Future of Design Education initiative received survey responses from 700 design faculty and practitioners internationally on how design education should change to meet the current demands of practice. This work is discussed in Davis and Dubberly (2023).

- **Systems interact dynamically over time and have consequences beyond immediate use.** Complexity is defined not only by the number of elements and their interdependent relationships, but also by their variety, volatility, and velocity of change. Stewart Brand, author of *The Clock of the Long Now* (1999), described functional layers of a healthy society: Fashion > Commerce > Infrastructure > Governance > Culture > Nature. The historical locus of design activity was the consumer-facing, fast-changing *Fashion* layer, which Brand described as "free to act as irresponsibly as society could bear" (Brand, 2018). However, action at this layer has causes and effects in other layers of society that change at different rates. For example, Americans toss 100–120 million cellphones into groundwater-polluting landfills each year (Repowered, n.d.). While designing reusable parts helps the environmental effort, changing this cultural behavior likely requires consumer right-to-repair policies and company triple-bottom-line metrics for measuring success. The design task is not only to imagine preferred conditions but also to understand how change happens.

- **Complex problems are not solved forever.** *Problem-solving* is an industrial-era concept that presumes ultimate resolution of some source of friction. Under the Industrial Revolution, society extended this concept to social conditions. However, in causal networks — rather than industrial causal chains — design action produces both intentional and unintentional effects elsewhere in the network and over time. The first task is to distinguish between root causes and symptoms — the level of generality — and then to decide the best level at which to act for positive results. Time, resources, expertise, and the likelihood of meaningful change aid in deciding where to intervene. And anticipating an "if-then" conditional sequence of actions may constitute a long-term design strategy when action is necessarily at a lower level. In this sense, "addressing the question at hand" or "improving the current situation" may better describe the work of contemporary design and research than "problem solving." And this problem framing is an essential 21st century design skill that is rarely taught in today's college classrooms. By the time students reach capstone courses, their inclination is to define independent projects as things they want to make rather than conditions they want to change.

- **Complex problem spaces can be framed in different ways.** Theorist Herb Simon argued for the term "problem spaces" rather than "problems" to better reflect initial ambiguity or variability regarding the boundaries of problematic situations. The intent of design today is to bring forth *new ways of being in the world* — to make conditions more sustainable, equitable, or just — not simply to make more things as it was in the industrial era. Therefore, the conceptualization of a problem space for design is subjective and political — more equitable than

what, in what ways, and for whom? Theorists Horst Rittel and Melvin Webber (1973) described design as paradoxical, grounded on one hand by infinite "makeability" and the unlimited potential of the future, and on the other hand by emotional engagement aimed at overcoming unequal social consequences. The understanding of a situation develops gradually and through argument. It requires a variety of stakeholders to advocate for different worldviews, not merely to test the usability of solutions.

- **Design considers the unknown future as well as the known present.** Philosopher Henri Bergson (1946) wrote that the *contingent future* (when something happens due to an external force) and the *optimization future* (when something planned comes to pass) treat the future as something that exists and merely needs to be revealed. He argued for the importance of the *novel future* — the emergent conditions that are unknowable today. Riel Miller, the head of foresight at UNESCO, warned that an unknowable future cannot be grasped simply through the search for a probable future through the logical extrapolation of current trends: "The challenge today is to incorporate 'unknowability' into the way we anticipate and engage in ongoing processes of discovery and invention in the present" (Miller, 2013).

- **Design solutions today arise from cross-functional teams and under increasingly agile processes.** Design, technical feasibility, and economic viability develop simultaneously and collaboratively, not in expert-driven sequences as they did in the past (Davis & Dubberly, 2023, p. 103). Research shows that when teams develop a conception of the problem collaboratively, they make the most creative use of their cross-functionality (Weingart et al., 2010). Designers learn from iterative releases, embedded feedback, and ongoing monitoring and research. Contemporary design is generational and updatable. It is characterized by good-enough-for-now versions, not the almost-perfect, one-off editions of the industrial era.

- **Data is the new design medium.** The significance of dematerialization is not about virtual-versus-physical, screen-versus-paper representations. And as "material," data is more than the numerical source for visual translations in an Edward Tufte, information design sense. For example, software developed in the College of Design at North Carolina State University overlays a viewshed map of the scenic Blue Ridge Parkway (what can be seen from various elevations in the mountains) with a map of uncultivatable land and plots of private ownership (Fels et al., 1995). The results are areas of land that if donated to the Nature Conservancy give owners tax advantages from property that can never be developed, support the eco-tourism industry, and protect nature in perpetuity.

The designers had to create maps and screen interfaces, but the real design work was converting data (in a values-driven computer stack) to stewardship.

- **Design shares control.** Platform design offsets the cost and time of upfront development for third parties who use them to create applications. Systems are customizable and yield control of form and content to users. Design methods are co-creative and engage stakeholders from the earliest stages of the design process.

Maintaining a social adaptation curriculum paradigm developed for the industrial era does little to address these changed expectations of design professionals under an ongoing shift in the practice paradigm that began with the Information Revolution. For example, if framing the situation is an essential 21st century skill, the faculty authorship of problems designed to foreground media affordances does little to advance students' development of problem framing skills for an environment of growing uncertainty. Further, such skills must be taught, not left to chance in a capstone course preceded by semesters defined by the things students make.

To some extent, the lag in design education's responses to changes in practice may account for the rapid rise of alternative credential and corporate bootcamp programs. Most of the students in these programs already hold college degrees and enroll for a change of career or upskilling (Davis et al., 2023a, p. 125), the latter suggesting that previous design study may not have prepared them fully for changing with practice. However, research shows that students who pursue short-term programs for technical training typically do not advance in their positions. Further, research shows that unless employers have multiple experiences with individual education providers, companies usually do not trust the evaluation strategies of alternative credential programs beyond a first-level screening of job applicants (Davis et al., 2023a, p. 132).

Alternative credential programs teach particular job tasks, not the systemic relationships that characterize professions and professional degree study (Bernstein, 2000, p. 59). Designer Jon Kolko (n.d.) described the patterning that defines professional behavior. *Patterning in the problem* is the actions a designer takes — doing, reflecting, and making adjustments. Kolko argued that designers do not acquire this expertise through random trial-and-error, but through repeated experiences with similar problems and contexts. *Patterning around the problem* is the "political, organizational, logistic, and cultural context of design." Design experts call up these patterns in ways that seem effortless, but novice designers need enough experiences to build what Kolko called "muscle memory" or recognition that "I've seen something like this before." He argued that developing these patterns requires the "slow learning" that is not possible under the short duration and singular projects of alternative credential study (Kolko, n.d.).

Eisner described two other curriculum paradigms worth mentioning in regard to college design programs today:

- The aim of a *personal relevance curriculum paradigm* is the individual student's growth. Meaning arises from the student's native abilities and personal choices of what to study in a resource-rich environment (Eisner, 1985). Programs admit students with visual histories and offer a range of medium-based electives in both art and design, from which students construct somewhat individual curriculum paths. Students move laterally across mostly unscaffolded courses; any prerequisites better reflect the level of student maturity or technical skills than faculty consensus regarding specific developmental knowledge or problem types. At the master's level, the preferred method of instruction is independent study with a few shared seminars on contemporary issues. Where available, doctoral study likely focuses on practice rather than evidence-based research, few methods are regularly taught to all students, and artifacts may substitute for a dissertation.

  A personal growth approach is common in design programs that share an administrative location with fine arts, and particularly where there is insufficient enrollment across art and design courses to ensure depth in specialized majors. Staff at the National Association of Schools of Art and Design, the accrediting body for college programs in the United States, anecdotally report an increase in curriculum proposals that reflect this paradigm as a response to budget cuts, loss of faculty positions, and a declining college-age student population. While some undergraduates under this approach may gain design employment, there is usually little faculty agreement or coursework regarding threshold preparation for entry-level design jobs. Published employment outcomes may better describe where a few alumni happen to work than the mission for which the curriculum is explicitly designed.

- The *social reconstructionist paradigm* is more recent and not concerned with graduates fitting into the current landscape of professional employment. The intent is activism that challenges the status quo; investigations of important problems that society has to address (Eisner, 1985). However, it is important to distinguish study under this paradigm from concern for social and environmental outcomes under other definitions of design practice. For example, in a 2023 research study by Köln International School of Design professor Birgit Mager found more than 80 service design programs that conduct applied projects in the public sector (Mager & Davis, 2024). 18F is a professional design office of the United States government with the sole purpose of improving citizen service experiences with federal agencies. Designers in these efforts prepare for making

change under the political and regulatory environments in which they work as employees or consultants.

Alternatively, the work of a social reconstructionist paradigm generally addresses action from outside the system it hopes to reform or replace and it makes no promises of typical design employment. Increasingly, design offices report interviewing recent graduates who "only want to do socially-oriented work," suggesting that design education may confuse students by the frequent use of "design for good" as a type of work rather than a sign of integrity in any design solution.

5. Principles and Models

Researcher Herb Simon offered a view of problem solving that could have implications for preparing today's college students for research-supported practices, as well as the generation of new knowledge. First with Allen Newell and later with Glen Lea, Simon's *problem spaces* describe the set of things the problem solver knows or postulates at a particular stage in understanding a problematic situation (Simon & Newell, 1974). There is an initial state of this knowledge, a goal state, and all states in between. The problem emerges through conjecture and inferences derivable under a premise regarding the nature of relationships in the problem space (Simon & Lea, 1974; Simon & Newell, 1974). Simon argued that this framing activity may not involve only the search of a single problem space for a solution, but also a comparison of the different knowledge sets found in multiple problem spaces for *concept attainment* or *rules discovery* (Simon & Lea, 1974, p. 115). As a practice example, Apple built its in-store service design on the model of concierge services in high-end hotels. The shared service principle is *triage.* In contrast to the supermarket service model of Best Buy — aisles of boxed products and queuing up at a cash register to pay for purchases — triage guided the physical design of the store and service components, as well as customer interactions with Apple staff.

In this sense, Simon's thesis offers insights for problem framing by undergraduates, as well as original research by more advanced students (Figure 4). Students extract principles or rules from recurring situations to inform models of *how things work.* They compare and critique propositional models of the situation and judge solutions under the conditions the model describes.

Burns and Vollemeyer (2000) emphasized the importance of models in understanding the situated tasks in Simon's search of problem spaces. Tests of these representations do not confirm a solution to a problem, but instead demonstrate the adequacy or inadequacy of the model in explaining the task, phenomena, or rules on which a future solution depends (Burns & Vollemeyer, 2000). This role is different from the

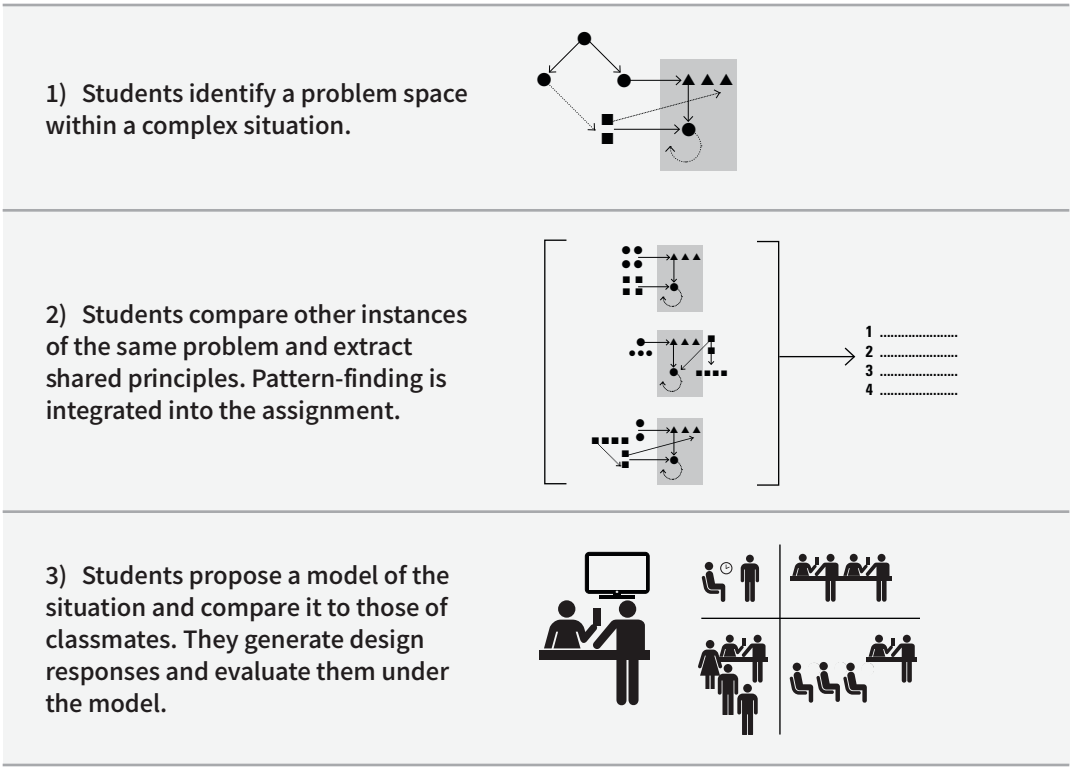

Figure 4. Problem framing through the search of multiple problem spaces for a model of "how things work."

industrial view of models as facsimiles of yet-to-be produced solutions and suggests that exploring a range of cognitive artifacts — concept maps, diagrams, user journey maps, and computer simulations, for example — is essential to addressing systems-level challenges in complex causal networks.

6. Increasing Research Accountability

Among the new expectations of designers is research that informs the outcomes of design action. However, a consequence of importing trade- and art-based practices as the traditional content of university design curricula is confusion regarding the definitions and standards for contemporary design research. In response to a study by *Metropolis Magazine* (Manfra, 2005), research definitions by 1,051 design faculty and students ranged from selecting colors to rigorous studies of user behavior. And while respondents ranked *sustainability* and *culture* as the most important topics for the field to study, *systems* and *ethnography* (anthropology) were at the very bottom of their lists. It is difficult to imagine how designers can address issues of sustainability without also understanding how systems behave and interact.

The responsibility of design to achieve particular outcomes also varies among organizations, even those engaged in mostly similar work. A 2019 report by Invision entitled *The New Design Frontier* (Blanda, 2019) studied the evaluation of designers' work in 2,200 digital product companies in 77 countries. The study found that the performance criteria for which designers were accountable depended on the management structure of their organizations. For example, when designers reported to product managers or engineers, *usability* was most important in their performance evaluations. When they reported to marketing, *brand equity* and the *conversion funnel* (the user's journey from an internet search to product purchase) were the only metrics that mattered. When designers reported directly to CEOs, all metrics were important, *except* usability (Blanda, 2019). These different evaluative criteria raise questions regarding the types of research that should support designers' work.

There is also little consensus regarding where students should acquire research dispositions and skills in their design education; that is, the levels of study at which students should be *users* versus *producers* of design research and the core competencies required for each. Library retrieval often equates with "research" in studio projects. And while medicine and management, for example, draw clear distinctions between the content of a practice versus a research doctorate, there is no consensus on such issues in design. These concerns extend to design faculty research output, typically generated without the benefit of a doctoral education in a context that often equates creative tangible objects with "knowledge," rather than "information."

Although the purpose of this article is not to sort out these issues, it is accurate to say that without some effort toward agreement regarding the nature and necessity of design research, it is difficult to describe how design faculty can reinvent academic programs and the body of knowledge in rapidly changing design fields.

7. Obstacles to a 21st Century Curriculum Paradigm

It is significant that despite additional new courses or objectives that reflect the current demands of design practice, an industrial-era approach to learning and inquiry persists in most institutions. Design programs are resistant to curricular and pedagogical change due to a number of factors:

- A long-held personal identity of the solo designer as a creative maker of material things as the locus of innovation;
- Political curriculum approval processes in higher education that make it easier to change courses than to reform curriculum or establish new curricular partnerships across administratively separated disciplines of study;

- Increasing program reliance on part-time faculty, who by contract may not have curriculum development or course-to-course coordination responsibilities;
- No agreement by the field regarding the purpose or core knowledge requirements of the terminal master's degree; and
- No preparation of terminal master's and doctoral students or part-time faculty for teaching, which results in instructors who teach how they were taught.

Some of these obstacles are likely to intensify under current social and economic pressures on higher education. However, standing still is not an option. Patterns of consumerist student migration from traditional curricula are already evidence of challenges to the continuing relevance of a 20th century teaching and learning paradigm. The students who seek out design programs are not the art students of the past. They bring to inquiry lived experiences in the rapidly changing possibilities of the Information Revolution. College and university programs owe them equal concern for how design education must change.

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Author

Meredith Davis is Emerita Distinguished Alumni Professor in the College of Design at North Carolina State University, where she served as Graphic Design department head and director of the PhD in Design program. She taught at the college level for 40 years, first at Virginia Commonwealth University and then at NC State. She is an AIGA Fellow and Medalist, Holladay Medalist, and NASAD Fellow. She served as president of the American Center for Design, co-authored the NASAD design accreditation standards, and conducted more than 100 curriculum reviews and consultations. She is the author of several books, including *Teaching Design,* and numerous articles, including the AIGA Design Futures Papers. She was principal in the firm Communication Design from 1979–1989.

INVITED ARTICLE

Digital Type Challenges

Charles Bigelow [a] **and Kris Holmes** [b]

[a] Cary Graphic Arts Collection, Rochester Institute of Technology, USA; [b] Bigelow & Holmes Inc.

Corresponding author: Charles Bigelow (chuck.bigelow[at]gmail.com)

Abstract: Second only to the invention of typography itself, digital typography has been the most transformative of the technological changes that have taken the hand setting of hand-cast and hand-printed type — the standard for 450 years — to worldwide ubiquity on the glowing screens of billions of smart phones and personal computers. Like its predecessor font technologies, digital typesetting began as a way to set text faster, but it has posed several challenges, of which the first and overarching one is resolution. Technical, perceptual, and economic in its aspects, resolution is the consequence of rendering traditionally analog forms as digital information, from pen, to punch, to photo, to pixel. Since 1980, we have designed digital type during its hegemonic advance toward world domination of literacy. That sounds scary, but the numbers seem benign: more people can now read more languages in more writing systems in more countries on more devices than ever before. The task of the type designer is to face the challenges of digital type and create the fundamental forms of what are often called fonts. We present many of the challenges we have confronted, and how we met them.

Keywords: design history; digital typesetting; font technology; handwriting; icons; Latin scripts; non-Latin scripts; traditional typefaces

1. Background

Digital typesetting began as a way to set text faster and became globally transformative, but it has posed several challenges that we, the authors, have had to confront. Before the advance of digital typesetting, we had studied calligraphy with Lloyd Reynolds, who taught not only the grace of handwriting but also the power of literacy expressed with

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University of Leeds (UK)
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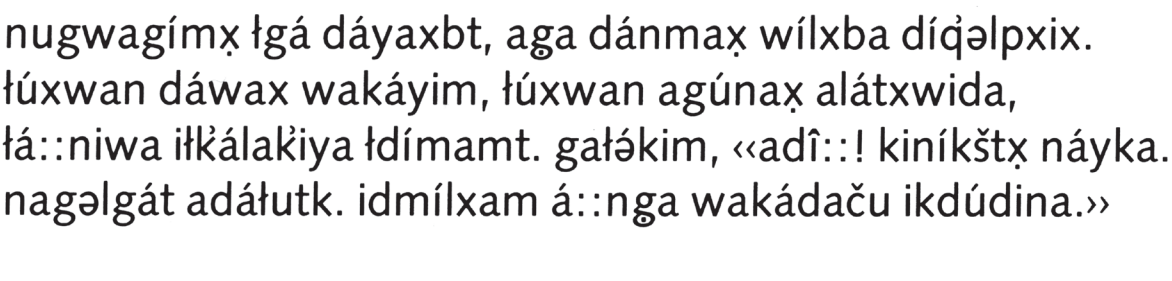

Figure 1. A passage in the Clackamas Chinook language in Syntax Antiqua. Type design by Hans Ed. Meier, diacritics by Bigelow & Holmes with Meier. Chinook narration by Victoria Howard; transcription, editing, and preparation for publication by Melville Jacobs (1958).

the simplest of tools — a skilled hand, a clear eye, a moving pen. Our first type design projects were for analog media: initial capitals for a letterpress limited-edition of *Moby Dick,* and linguistic diacritics for a phototype font of Syntax Antiqua, to compose a native American language of Oregon (Figure 1). In the *Moby Dick* capitals, we strove to express the billowing sails and flashing whale flukes of a famous American novel. With Hans Ed. Meier's Syntax, we worked to help a subtle typeface express an evocative yet nearly lost oral literature.

When we began to work with digital type, no matter how daunting its complexity and machinery, we stuck with the basics Reynolds taught: expression, simplicity, clarity. To those we added fun.

We have worked together on type design since 1976 and first encountered digital type in August 1977 on a visit to Linotype where we met Mike Parker, director of type development. There we saw large characters digitized for the new Linotron 202 digital typesetter, and we heard of the IKARUS system invented by Peter Karow for the digitization of type (Bigelow, 1979). Then in September that year, we read an article in *Scientific American* by Alan Kay (1977) with intriguing photos of the screen of the Xerox Alto personal workstation.

In 1979, our friend Michael McPherson wrote his graphic design master's thesis at Rhode Island School of Design on "Electronic Textsetting," a meticulously researched and elegantly designed forecast into the looming future of digital typography. That summer we took courses in calligraphy and type designs with Hermann Zapf at Rochester Institute of Technology (RIT). We learned of Zapf's own digital typefaces, Marconi and Edison, and heard his persuasive argument that type design for new technologies should be new and original.

In 1981, Patricia Seybold and John W. Seybold of the Seybold Consulting Group encouraged us to write up our studies of digital type for the typesetting industry journal, the

Seybold Report (Bigelow & Seybold, 1981; Bigelow & Seybold, 1982a,b). In 1982, Bigelow (the first author) was appointed assistant professor of digital typography at Stanford, and with Donald Day wrote about digital typography for *Scientific American* magazine (Bigelow & Day, 1983).

That same year, Bigelow organized a seminar, "The Computer and the Hand in Type Design," at Stanford for the Association Typographique Internationale (ATypI). The August seminar featured working demonstrations of new computer tools for creating digital type, along with live demonstrations of traditional letter arts including carving in stone, punch cutting in steel, and casting in lead, with a calligraphic keepsake of quotes from women storytellers in history. The seminar featured lectures by type designer Hermann Zapf, typographer and scholar John Dreyfus, printer Jack Stauffacher, computer scientist Donald Knuth, stone carver John Benson, and other type designers and lettering artists.*

The Stanford seminar revealed more challenges of digital type.

2. Twelve Challenges

2.1. Challenge 1: Resolution and Pixels

Unlike the smooth analog forms of traditional metal and photographic printing types, digital type is composed of small picture elements, or *pixels.* The term *resolution* is often used to mean *pixel density,* the number of pixels per unit of measure (e.g., inch [ppi] or centimeter).†

Without digital equipment, we first experimented with letter type designs for computer screens using graph paper, filling in squares to simulate bitmaps of letters. At that time, cathode-ray tube screen resolutions were around 72 pixels per inch, at which a 12-point font was conveniently 12 pixels tall and its stems one pixel thick. A simulated italic font would have one or two jags in its stems, depending on italic angle, and a bold weight would have stems two pixels thick. No in-between weights were possible. A few years after our early experiments, we designed working screen fonts for personal workstations, particularly the DEC VaxStation 1 and the Tektronix Smalltalk workstation (Bigelow, 1986).

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* The seminar was documented through proceedings in a 1985 *Visible Language* special issue, "The Computer and the Hand in Type Design," with guest editors Charles Bigelow and Lynn Ruggles (Bigelow, 1985).

† Alvy Ray Smith (2021), a co-founder of Pixar, provides a comprehensive account of the pixel in theory and practice, and Robert Morris (1989) provides a discussion of the perception of type quality at digital resolutions.

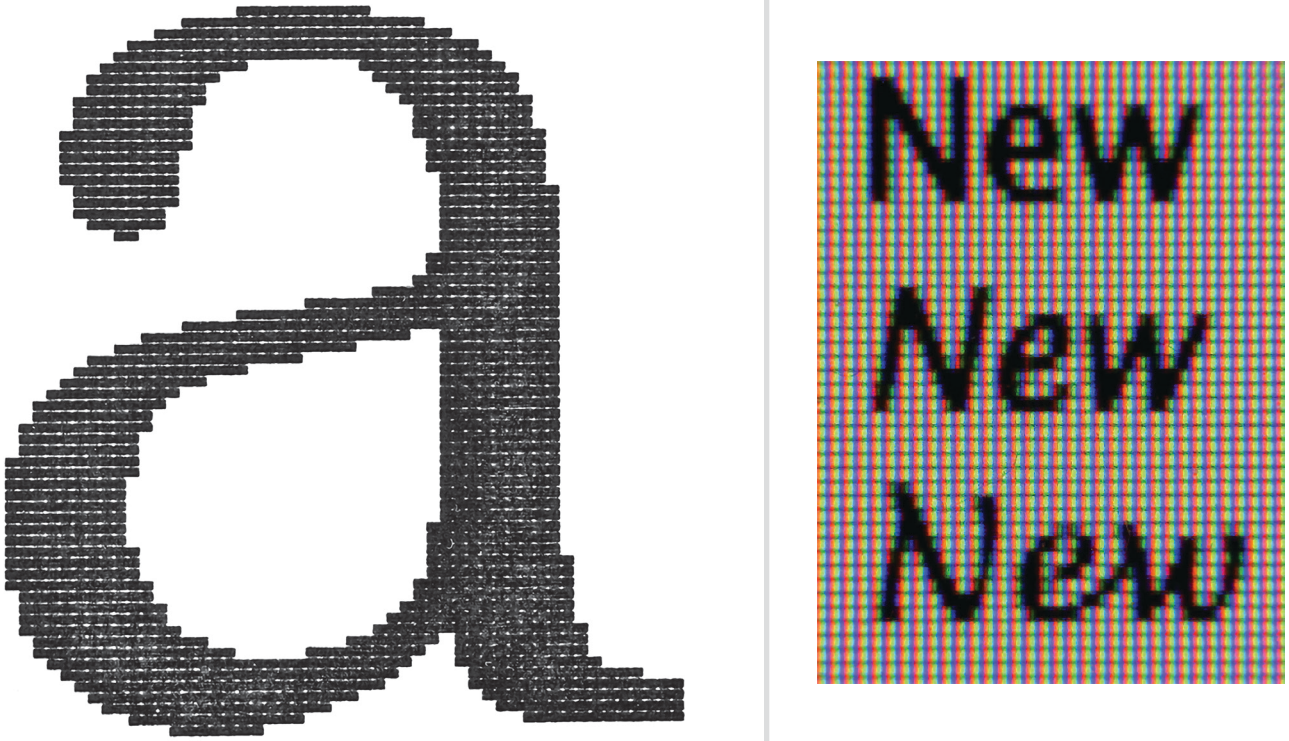


Figure 2. Enlarged bitmap of the letter “a” from Edison, showing typical “staircasing” of pixels on curves, limited by resolution (left). This resolution is high enough that the staircases are softened at small sizes on newsprint. For a reproduction of digital display: a close capture of Lucida variations — roman, italic, handwriting — at a screen resolution around 90 pixels per inch (right).

Marconi and Edison. We were hardly the first to design fonts by bitmap construction. In 1976, Hermann Zapf, assisted by his wife Gudrun Zapf von Hesse, created high resolution bitmap typefaces for the Digiset typesetting machines of Doktor-Ingenieur Rudolf Hell (Zapf, 2000). First they designed the Marconi family for headlines of newspapers, the major users of Digiset equipment. The Zapfs created the digital letters pixel by pixel, using pre-ruled grids. In 1978, their next digital font family was Edison, a newspaper text face likewise for the Digiset. At high resolution, around 230 pixels per centimeter, Digiset pixels blended together to produce smooth letters like standard news faces (Figure 2). Later, both families were produced by Dr.-Ing. Hell as digital outline fonts, using the IKARUS system, invented by Peter Karow in Hamburg, Germany (Karow, 1998, 2019). It is difficult at this far remove in time to convey how exciting it was for us to learn that two of the most esteemed type designers of the 20th century were creating digital fonts.

2.2. Challenge 2: Type Revivals as Digital Fonts

In the 1970s, a few methods of defining letter outlines by computer were invented. The most efficient use of IKARUS began with large outline letter drawings, which reduced the amount of subsequent editing needed compared to digitizing photographic enlargements of letters.

In the early 1980s, Dr.-Ing. Hell engaged Holmes (the second author) to draw versions of classical 18th century typefaces Baskerville and Caslon for IKARUS digitization and adaptation to Hell's digital typesetting equipment (Figure 3). Although digitizing 20th century phototype versions of classical faces had become common, Holmes instead studied specimens of original Baskerville punches and type cast from their matrices by the Parisian Deberny & Peignot foundry in Paris, as well as microscopic examination of 19th century Baskerville specimens from the Frères Bertrand type foundry. Based on these, Holmes drew large, precise outlines on dimensionally stable drafting mylar, in order to avoid paper shrinking or expansion when sending drawings from the U.S. to Kiel, Germany, where Dr.-Ing Hell was located. Dr.-Ing. Hell had asked that Holmes' drawings regularize features such as stems, serifs, and alignments, to conform to Hell's Digiset machine resolutions.

2.3. Challenge 3: Original Design from Outlines for Digital Systems

Isadora. In the early 1980s, Dr.-Ing. Hell planned to introduce smaller versions of Digiset machines in the American market for smaller newspapers and publications as well as commercial and advertising typography. The firm wanted a new typeface that would show off the creative possibilities of its digital machines.

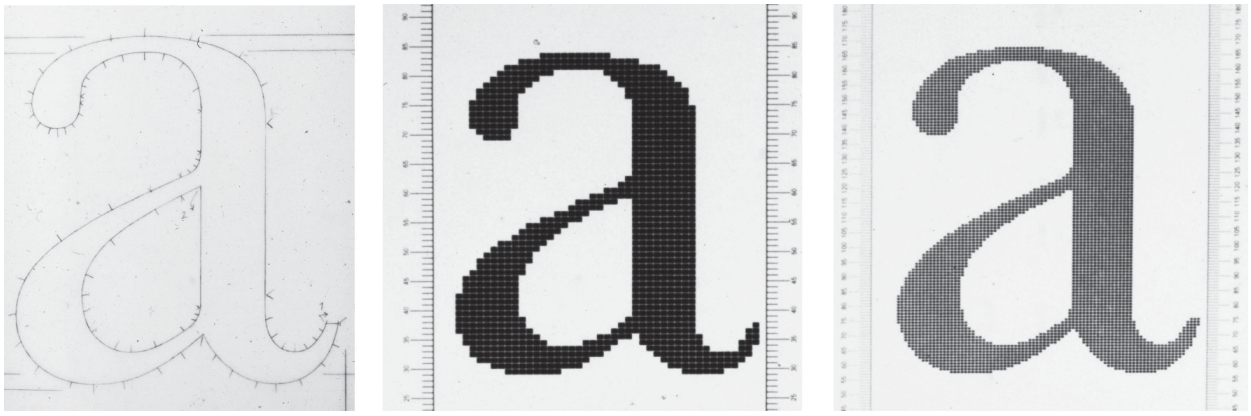


Figure 3. Drawing of Baskerville lowercase letter "a" by Kris Holmes, circa 1980, adjusted to Digiset grid, with IKARUS spline indicators (the little tick marks).

In traditional metal typography, the connecting script typeface was among the most difficult styles to cast and print well. Delicate hairlines and serifs tended to break, exposing gaps instead of connections. Highly slanted scripts were also difficult to achieve in metal. Holmes felt that those problems could be solved in digital typesetting, so she proposed to Hell a new script face to show off the Digiset machine's ability to render elegant designs in fashion and display advertising (Figure 4). Her name for it was Isadora, evoking the grace and originality of the famed early modern dancer, Isadora Duncan. Holmes' design proposal met with approval from advisers to Dr.-Ing. Hell, Hermann Zapf and Swiss designer Max Caflisch (Holmes, 1985, 2015). Holmes designed her flourished script while implementing the careful adjustments and regularities needed for the resolutions of Hell's typesetters. Her large, fine-line drawings were digitized with the IKARUS program. Some years later, the International Typeface Corporation (ITC) acquired Isadora for general licensing to phototype equipment manufacturers as well as digital manufacturers.

2.4. Challenge 4: Laser Printing and Hi-Res Typesetting

After the seminar "The Computer and the Hand in Type Design," we began work on a new type family for laser printing and screen display. We named the type Lucida to signify that it would be rendered with light — laser light in print and phosphorescent light on cathode-ray tubes. We believed that with simple and regularly repeated letter shapes, the type could be rendered reasonably well by laser printers, despite distortion and noise in the medium resolution printers. We crafted basic patterns for serifs, stems, bowls, and other features, and repeated those throughout the typeface. The result was a sturdy design intended to be a workhorse at text sizes at medium resolution (Figure 5).

In 1984, Michael Sheridan, director of typography at Imagen, a laser printer manufacturer in Silicon Valley, welcomed the challenge of producing Lucida for 300 dpi Imagen laser printers. To generate digital outline data for the printer company, we drew large outlines of Lucida letters and digitized them with IKARUS. Imagen converted our IKARUS data to their proprietary printer font format and produced the first specimen of Lucida as a keepsake for the September 1984 meeting of ATypI in London, England (Bigelow & Holmes, 1986, 2018).

Serifed Lucida was found to be resistant to digital noise and maintained adequate readability in 300 dpi printing (Bowden & Brailsford, 1989), and Adobe found that it also remained more legible after faxing than some other typefaces. Progress in rasterization technology soon made it possible to render refined type designs at medium resolutions, so the original serifed Lucida was not as necessary, but it served as the basis for an extended family of future design variations.

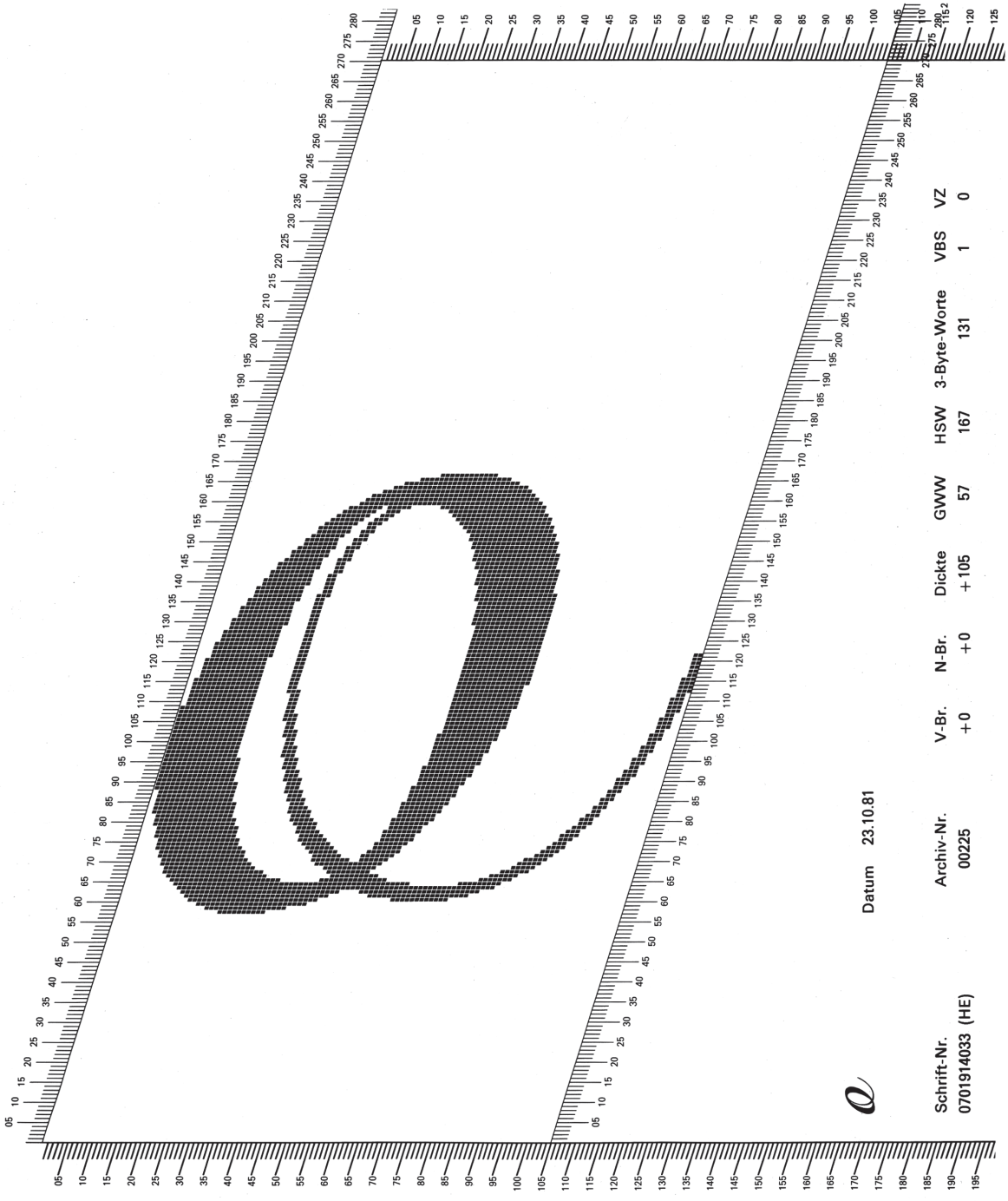
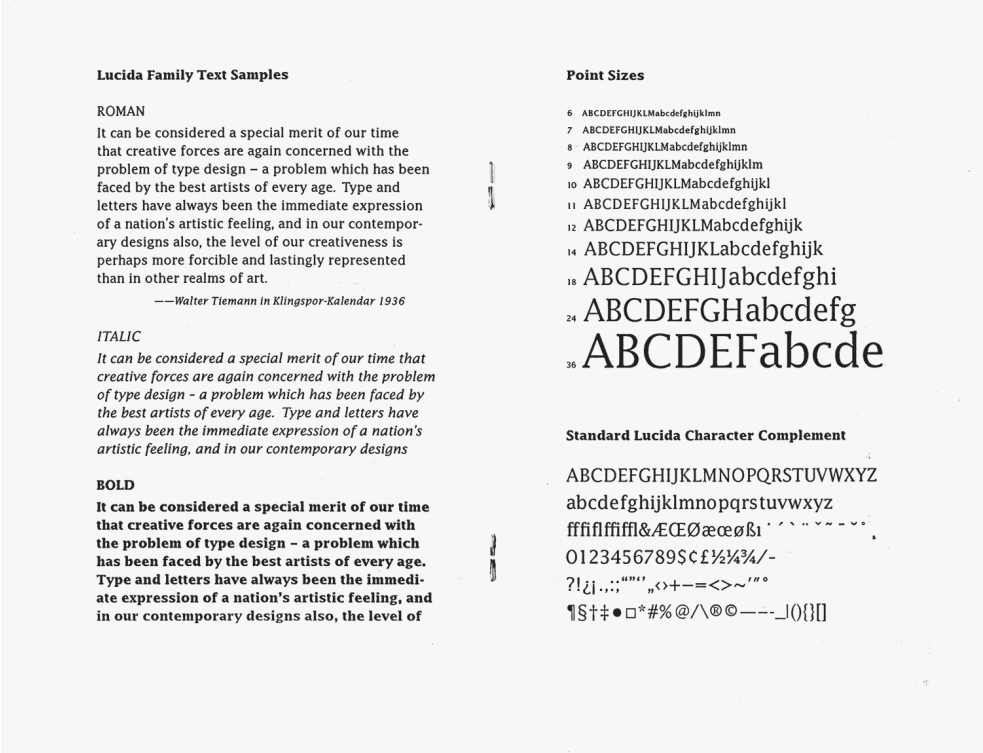


Figure 4. Isadora “o” clean proof for Digiset.



Lucida Family Text Samples

ROMAN

It can be considered a special merit of our time that creative forces are again concerned with the problem of type design – a problem which has been faced by the best artists of every age. Type and letters have always been the immediate expression of a nation's artistic feeling, and in our contemporary designs also, the level of our creativeness is perhaps more forcible and lastingly represented than in other realms of art.

——*Walter Tiemann in Klingspor-Kalendar 1936*

ITALIC

It can be considered a special merit of our time that creative forces are again concerned with the problem of type design – a problem which has been faced by the best artists of every age. Type and letters have always been the immediate expression of a nation's artistic feeling, and in our contemporary designs

BOLD

It can be considered a special merit of our time that creative forces are again concerned with the problem of type design – a problem which has been faced by the best artists of every age. Type and letters have always been the immediate expression of a nation's artistic feeling, and in our contemporary designs also, the level of

Point Sizes

6 ABCDEFGHIJKLMabcdefghijklmn
7 ABCDEFGHIJKLMabcdefghijklmn
8 ABCDEFGHIJKLMabcdefghijklmn
9 ABCDEFGHIJKLMabcdefghijklm
10 ABCDEFGHIJKLMabcdefghijkl
11 ABCDEFGHIJKLMabcdefghijkl
12 ABCDEFGHIJKLMabcdefghijk
14 ABCDEFGHIJKLabcdefghijk
18 ABCDEFGHIJabcdefghi
24 ABCDEFGHabcdefg
36 ABCDEFabcde

Standard Lucida Character Complement

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
fffiflffiffl&ÆŒØæœøßı ˋ ´ ˆ ¨ ˚ ˜ ¯ ˘ ˛
0123456789$¢£½¼¾/-
?!¿ı .,:;"“”‘’ „‹›+−=<>~′″°
¶§†‡●□*#%@/\®©—–-_|(){}[]

Lucida Sans Weights	CSS
a quick brown fox	100
a quick brown fox	150
a quick brown fox	200
a quick brown fox	250
a quick brown fox	300
a quick brown fox	350
a quick brown fox	375
a quick brown fox	400
a quick brown fox	425
a quick brown fox	450
a quick brown fox	500
a quick brown fox	550
a quick brown fox	600
a quick brown fox	650
a quick brown fox	700
a quick brown fox	800
a quick brown fox	900
a quick brown fox	999

Figure 5 (above). Imagen Lucida specimen, laser printed at 300 dots per inch in 1984.

Figure 6 (left). The gamut of 18 Lucida Sans weights. A humanist sans-serif in barely noticeable weight differences for graphic and interface designers to fine-tune perceptual and psychological nuances for different contexts and functions. The numbers represent weight designations in Cascading Style Sheets (CSS) for online typography.

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The Next Computer Revolution

In less than 50 years computers have become essential to industrial society; in the next phase they will grow more powerful by at least an order of magnitude and become a ubiquitous intellectual utility

by Abraham Peled

When it was first invented, the computer was an interesting laboratory curiosity. Today it is inconceivable that contemporary industrial society could exist without it. The domestic and international financial industry, manufacturing and transportation all rely on electronic flows of information. Technologists who design materials or biologically derived pharmaceuticals depend on the computer, as do physicists who are exploring the nature of energy and matter. The way

network will be capable of linking any combination of individuals who need computing, whether they are physicians trying to reach a difficult diagnosis, investment bankers structuring a deal, aeronautical engineers creating a new airframe, astrophysicists modeling the evolution of the universe or students studying for an examination.

Although the emergence of such an intellectual utility represents a profound change in society's relation

cult yet feasible engineering refinement of current technologies [see "Chips for Advanced Computing," by James D. Meindl, page 78]. X-ray lithography using synchrotron radiation, new materials and better device structures will probably improve the density of components on a chip by a factor of 20 to 40. Such processors will probably be from six to 12 times faster than existing ones.

These improvements will be compounded by the steady increase of parallelism in computing systems

Figure 7. Lucida Bright was a new version of Lucida for high-resolution digital typesetting around 720 dots per inch, more than twice laser printer resolution at the time. The titles of the article are Galileo roman and the subtitles are Galileo italic.

Lucida Sans. In 1985, we finished a family of sans-serif companion faces for Lucida (Figure 6). The concept of uniting serif and sans-serif faces in a single family was not original to us. It was first conceived by Dutch type designer and calligrapher Jan van Krimpen in the 1930s at the Enschedé printing house and type foundry. We had first gotten the idea in the early 1970s from an essay by Erich Schulz-Anker (1970) comparing the humanist sans-serif typeface Syntax-Antiqua, by Hans Eduard Meier, to the humanist serifed Sabon typeface, by Jan Tschichold. Lucida Sans has since proven popular, having been licensed and distributed by Adobe, Apple, Bell Labs, Microsoft, Monotype, Sun Microsystems, Oracle, the TeX Users Group, and other firms and organizations.

Lucida Bright. In 1986–1987, when we redesigned *Scientific American* magazine for more expressive use of digital typography, we created Lucida Bright for the text. With refined modulation, thinner hairlines, longer serifs, and tighter letter-fitting to narrow columns, Lucida Bright gave a brighter look on the coated paper of the magazine (Figure 7). We used Lucida Sans for other contexts in the magazine, thus carrying out our concept that serif and sans-serif of the same extended family can be used together effectively.

Galileo. We designed an even brighter typeface for article titles in *Scientific American*. It had very high-contrast between strong vertical stems and very thin hairlines and serifs

in the Didot style that had been used in the magazine before the digital era (Figure 7). Thus, there were three levels of "brightness" in the magazine, depending on the degree of contrast between thick and thin letter elements: high contrast in the titling; medium contrast in the Lucida Bright running text; and low contrast in the Lucida Sans sections. We called the face Galileo but did not release it to the general market. Perhaps someday we will.

Lucida Fax. In 1992, Microsoft included Lucida Bright and Lucida Sans in the Microsoft Font Pack for Windows, along with Lucida Fax, a version of the original Lucida serifed face modified for faxing.

Lucida RSVP. Around the year 2001, Robert Morris, a mathematician and computer scientist with strong interests in imaging and typography, asked us to assist in a laboratory experiment investigating a perennial debate in 20th century typography: Which type style is more legible, serifed or sans-serif? Previous studies of the question were less than persuasive because the sample faces were usually disparate in most salient features. For example, in a study comparing serifed Times Roman with the sans-serif Helvetica, the two typefaces differed in x-height, capital height, ascender and descender lengths, character widths, inter-letter spacing, stem thickness, hairline thickness, underlying letterforms, and overall weight (the ratio of black to white).

Figure 8. Lucida RSVP, with color indicating the removal of serifs from a Lucida Fax base for an experimental study testing the legibility of serifed versus sans-serif type.

For Morris' study, we took Lucida Fax and removed the serifs from one version and left them on another (Morris et al., 2002). We made a few other adjustments in lockstep between the faces, so that ultimately they differed in only one respect, the presence or absence of serifs (Figure 8). The experiment was conducted with a computerized text presentation technique called *rapid serial visual presentation,* or RSVP, in which the words of a text are rapidly flashed on the center of a computer screen as readers passively focus on the screen without significantly moving their eyes. Hence, we called the new font Lucida RSVP. The study concluded that during RSVP, reading for sans-serif type is approximately 20% faster at very small sizes. But at larger sizes, this advantage disappeared. Thus, it may be "counterproductive" to render serifs at small sizes.

2.5. Challenge 5: Monospaced

Typewriter, fixed-pitch, fixed-width, and *monospaced* are equivalent terms for typefaces in which all letters and characters have the same set width (Figure 9). That is, the horizontal width of each letter, including not only the black letter but also the white areas on its sides, are identical. The space occupied by an "i" is the same width as the space of an "m." This was the standard form of most typewriter fonts for more than a hundred years because it enabled simpler mechanisms and easier typing. Early computer systems and applications, particularly for programming and line printing, often assumed monospaced fonts, including those that had been designed for IBM typewriters, including the famous Courier by Howard Kettler and Letter Gothic by Roger Roberson.

Lucida Sans Typewriter. In 1986, Imagen asked us to make a monospaced version of Lucida Sans for programmers who used systems and applications that assumed fixed-pitch fonts. Accordingly, we "monospace-ized" Lucida Sans, giving the letters and characters equal widths while keeping the x-height and vertical proportions identical to those of Lucida Sans. The result looked a lot like Lucida Sans — a quick glance might not reveal a difference between the proportionally spaced and monospaced versions. In the dawn of personal computing in 1986, millions of people still used typewriters, so we called the monospaced design Lucida Sans Typewriter. More robust in weight but more economical in space than Courier, it became popular among Imagen's customers.

We added bold, italic, and bold italic styles to make a typeface family, which Microsoft included in its Font Pack for Windows in 1992. In 2018, after most people had stopped using mechanical typewriters, we added Greek and Cyrillic alphabets along with symbol and graphics characters to Lucida Sans Typewriter and renamed it Lucida Grande Mono. (Well, the "Grande" is because it is more grandiose than its first incarnation.)

Lucida Console. Next, Microsoft asked us to modify Lucida Sans Typewriter for the "console" window in its operating systems. To fit the font into display limitations of that

ABCDEFGHIJKLMNOPQRSTUVWXYZ
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ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ
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ABCDEFGHIJKLMNOPQRSTUVWXYZ
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Figure 9. Digital typewriter variations showing different styles, weights, widths, postures, and details of monospaced versions of Lucida.

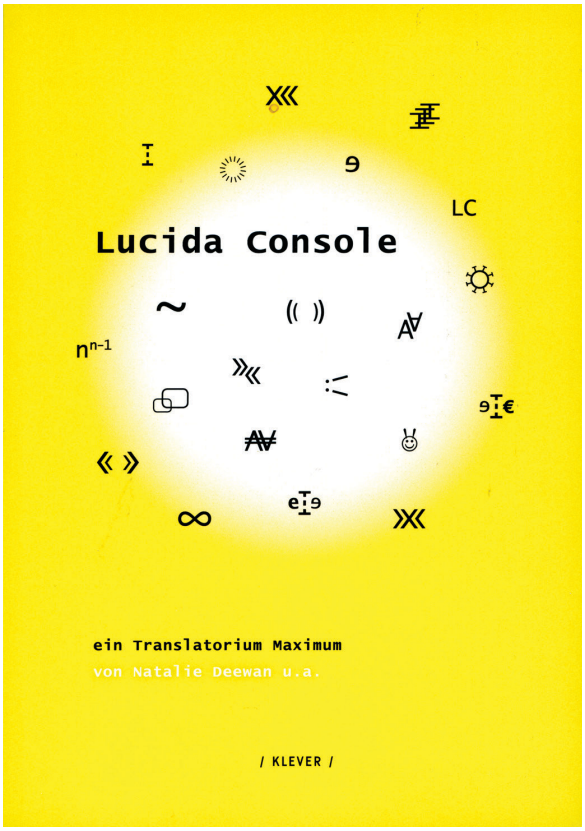


Figure 10. *Lucida Console,* book by avant-garde writer Natalie Deewan (2022).

special window, we shortened the capitals so European accents could fit into limited space, and to expand the international utility of the face, we added Greek and Cyrillic letters and accents, along with sets of symbols and graphic characters, almost tripling the number of characters in a standard font.

This niche adaptation to a particular operating system turned out to look unexpectedly cute and attracted an avant-garde following. An English rock band called itself The Lucida Console, and an avant-garde writer in Vienna wrote a multilingual, McLuhanesque book entitled *Lucida Console* using the eponymous font (Figure 10; Deewan, 2022). One of the thrills of designing typefaces is seeing them used in adventurous, imaginative, and unexpected ways.

Lucida Typewriter. After Lucida Sans Typewriter, we were asked for a serifed monospaced font. The most successful typewriter face of all time is Courier, which was designed by Howard Kettler for IBM electric typewriters in the 1950s. Courier is a subtle but superb design, and though often imitated, IBM's original design remains superior to the later but cruder imitations.

Instead of attempting to imitate Courier, we adapted Lucida Fax to monospacing, relying on its proven resistance to digital noise and its more robust weight to serve as

a sturdy workhorse when a monospaced face is needed. At 10 point, Lucida Typewriter fits 10 characters per inch, the same as 12 point Courier, thus being more economical in its vertical dimension than Courier, with a more chiseled appearance.

Go Mono. In 2016, the developers of the Go programming language at Google asked us to provide free fonts for the language. To honor the anniversary of the first release of the Go language, we designed the Go Mono typeface family. It contains three weights — normal, medium, bold — in roman and italic "postures" (i.e., upright or leaning) and a serifed monospaced design with a narrow set.

2.6. Challenge 6: Pictograms and Symbols

As we developed the Lucida family of types, we designed pictograms and ideograms and combined them into fonts we named Lucida Icons, Arrows, and Stars. We harmonized the non-alphabetic with alphabetic fonts by equalizing the heights, proportions, and weights of the pictorial and ideographic images with those of the Lucida alphabetic faces.

In the Lucida Icons font, we included pictograms of computer paraphernalia such as floppy disks, hard drives, monitors, keyboards, mice, track balls, and tape drives. Metaphorically, we included images of file folders, mail, mailboxes, pen, pencil, brush, and text files. Various dingbats were hand signs, smile and frown faces, playing card suits, astrological signs, geometric figures, medallions, flowers, and vines.

In 1990, Microsoft licensed the Icons, Arrows, and Stars fonts and distributed them with a beta-test release of Windows 3.1. After thousands of test users liked our Icons, Arrows, and Stars fonts, Microsoft proposed to buy them outright and rename them Wingdings to go with Windows (Figure 11). We agreed. Microsoft chose to bundle only one font with Windows, however, so they selected assorted characters from each of our three fonts, assigned new mappings to the standard QWERTY keyboard, and combined them into a single font. The remaining characters from the three fonts were released in a later Font Pack as Wingdings 2 and 3.

The earliest writing systems, Sumerian cuneiform, Egyptian hieroglyphs, and Chinese characters, began with pictographic images. Those eventually evolved into abstract signs. More recently and over centuries, typography, various signs, symbols, and ornaments have been devised to supplement alphabetic texts. These graphical symbols, some called *fleurons,* others called *dingbats,* continue to be of use. In the 1970s, when pictograms were used in programming environment research at Stanford University and Xerox, they were called *icons,* the term that stuck when it appeared on the Xerox Star and Apple Macintosh. More recently, Japanese emoji, originally seen in Japanese comics and later in electronic products, are now widely popular and thousands have been included in the Unicode standard (Unicode Consortium, 2024). Our venture into

pictography was just one moment in the thousands of years of ongoing evolution, sometimes forward, sometimes backward, in writing systems.

Predictably, more than three decades after Wingdings was launched, some of the objects depicted by our icons, such as the floppy disk, have become obsolete, while the abstract symbolic letters of our alphabetic fonts have remained fully functional in trillions of text exchanges over the internet. The floppy disk icon does, nevertheless, continue to be used to signify *save,* a shift of meaning from an object to a function. It has happened many times before. Few readers today see the capital "A," which acrophonically signified an ox head some 3,000 years ago in an early Semitic alphabet, as anything but an abstract sign for a vowel in various languages.

2.7. Challenge 7: Handwriting to Type

The first Lucida designs were responses to functional challenges, particularly resolution, but also were intended to facilitate pragmatic usage, such as programming. We were concerned with crafting designs that worked well for users of emerging technologies.

Figure 11. Festive sample of Wingdings, released by Microsoft in 1992.

As resolutions increased and grid-fitting technology improved, we explored the design of typefaces that could have been taken directly from handwriting into type without passing through earlier generations of typography.

Sierra: from late humanist handwriting. It is generally believed that our modern roman and italic types were based on the handwriting of humanist scribes of the fifteenth century, beginning with Poggio Bracciolini and Niccolò Niccoli early in the century and evolving into more calligraphic styles written by Antonio Sinibaldi and Bartolomeo Sanvito late in the century.

Holmes (the second author) experimented with twisting an edged pen to generate serifs in a late humanist style and turning that into a digital typeface for Dr.-Ing. Hell. The result is a digital typeface that is not an imitation or emulation of 15th century scribes, but an exploration of an alternate path from handwriting directly to digital (Figure 12). She named it Sierra, for the mountain range near where she grew up in California's Central Valley (Figure 13).

Lucida Blackletter: from Burgundian Bâtarde. Holmes had admired cursive blackletter handwriting for its dark, complex, dynamic action and chose Burgundian Bâtarde, a style of handwriting popular in the Low Countries in the 15th century and notably used by William Caxton in printing the *Canterbury Tales* in 1476, the first book printed in England. Instead of copying Caxton's type, Holmes first wrote the Bâtarde hand with an edged pen and then simplified it to attenuate its complex flourishes and make it

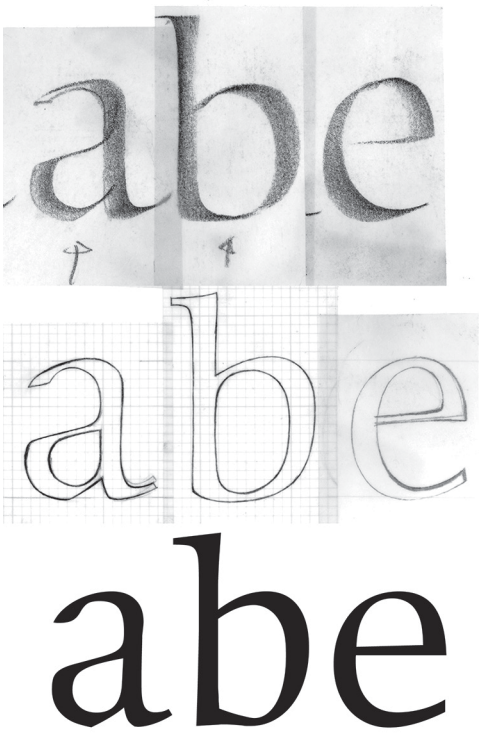


Figure 12. Sierra sketches by Kris Holmes for a type derived from broad-edged pen handwriting, here simulated by broad-edged pencil sketch.

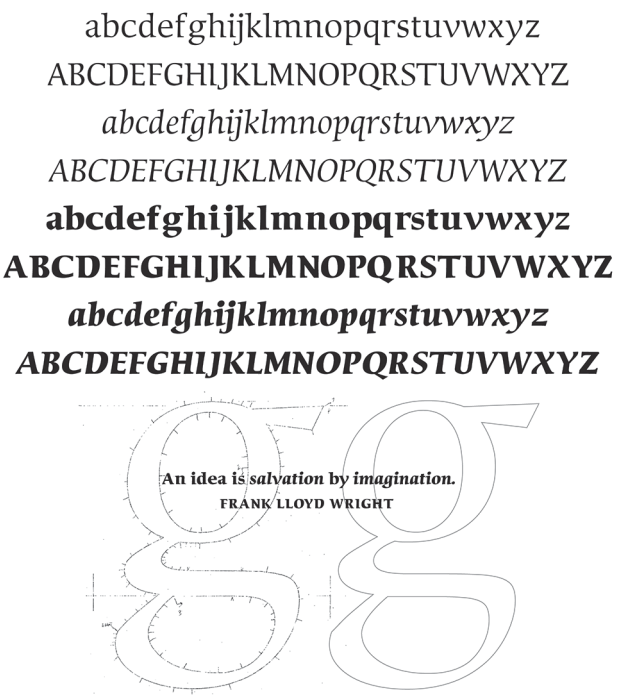


Figure 13. Sample of Sierra digital type family in several styles.

Whan that Aprill, with his shoures soote
The droghte of March hath perced to the roote
And bathed every veyne in swich licour,
Of which vertu engendred is the flour;
Whan Zephirus eek with his sweete breeth
Inspired hath in every holt and heeth
The tendre croppes, and the yonge sonne
Hath in the Ram his halfe cours yronne,
And smale foweles maken melodye,
That slepen al the nyght with open eye
(So priketh hem Nature in hir corages);
Thanne longen folk to goon on pilgrimages
And palmeres for to seken straunge strondes
To ferne halwes, kowthe in sondry londes;
And specially from every shires ende
Of Engelond, to Caunterbury they wende,
The hooly blisful martir for to seke
That hem hath holpen, whan that they were seeke.

Figure 14. Geoffrey Chaucer: General Prologue to the *Canterbury Tales.* Composed in Lucida Blackletter (Hellinga, 1982), a simplified version of the Burgundian Bâtarde type that William Caxton used in his 1476 edition of the *Canterbury Tales.*

Figure 15. Lucida Blackletter in a Parisian restaurant menu. The restaurant is in Paris but the menu is in Spanish for tourists. The Burgundian Bâtarde blackletter style is favored by French, Spanish, and English.

more acceptable to modern readers. The result was Lucida Blackletter, which Microsoft distributed in 1992 (Figure 14). In the U.S., the type appears more often during the winter holiday season, when blackletter types miraculously become more legible to holiday revelers, but it is used in France in other seasons as well, because the Bâtarde style was popular in handwriting and typography in the 16th century (Figure 15).

Lucida Calligraphy: from chancery cursive. The calligraphic hand taught by Lloyd Reynolds at Reed College was chancery cursive, a refined humanist style popular among humanist scribes working in the Vatican chancery in the 15th century. Humanist cursive was first cut in type in 1501 by Francesco Griffo and the chancery cursive was taught by Ludovico degli Arrighi and cut by Lautizio Perugino for Arrighi's book on chancery cursive printed in 1524.

Arrighi's style of chancery was revived as italic handwriting in England and America in the 20th century, and promoted on the basis of its legible letterforms and easy manual rhythm. In 1980, when Holmes reviewed Hermann Zapf's Chancery typeface

for phototype by International Typeface Corporation, she delved into the history of chancery cursive in handwriting and type (Holmes, 1980).

To render Arrighi's famous hand as digital type was a daunting proposition, a conflict of elegance versus resolution. We decided to include it in the Lucida family but increased its x-height to equal that of other Lucida faces, thus enabling the central portions of the letters to contain more pixels for locally higher resolution. To compensate for the large x-height, we shortened the ascenders and descenders and widened the letters. Because chancery cursive was a favorite of calligraphers and often the only calligraphic face that people recognized easily, we named it Lucida Calligraphy (Figure 16). It was launched by Microsoft in 1992 along with other Lucida fonts in the Font Pack for Windows and has been in wide use ever since.

Apple Chancery: chancery cursive. In 1993, Apple asked us to design a new typeface to display the advanced capabilities of the new font technology they had just invented, TrueType GX, which could compose complex combinations of swash letters, ligatures, and context sensitive letter variations. As it happened, they showed us an example of traditional chancery cursive! Holmes proposed basing the new font directly on the italic handwriting taught by Lloyd Reynolds at Reed (Figure 17).

To create a face closer to the handwritten style of chancery that might be written by a modern scribe, Holmes gave the face luxurious ascenders and descenders, only slight slant, and narrower letters than in Lucida Calligraphy. Apple launched it as Apple Chancery and still includes it with MacOS. The face looks less like type and more like the italic handwriting written by generations of calligraphers in England, America, and elsewhere. It was even used in the menu of the wedding reception for the marriage of Prince William and Catherine Middleton in 2011.

2.8. Challenge 8: Connecting Scripts and Semi-Scripts

In traditional metal typesetting, connecting scripts had problems. One problem was getting the thin joining strokes to align correctly and appear to connect letters without visible gaps. Another problem was that delicate joining strokes were susceptible to battery and breakage, leaving evident gaps. There were practical restrictions on the degree of slant of script letters cast in metal.

Lucida Handwriting. Holmes had previously solved script joinery problems with the formal joining script of Isadora. A few years later we felt the Lucida family should have a joining script, but one like informal handwriting. The result was Lucida Handwriting, a joining script that looks like carefree, flowing handwriting (Figure 18; and analyzed in a dissertation, Figure 19). It was first distributed by Microsoft in 1992. We often see it used as a joining script as intended, but sometimes the unconnected capital letters are used in all-capital settings, where they look free and active.

Figure 16. Four weights of Lucida Calligraphy. It is a chancery cursive designed for screen display and laser printing in the 1990s and is still popular today. The weights vary as if the script were written with different widths of a broad-edged pen. The broader the width, the bolder the script.

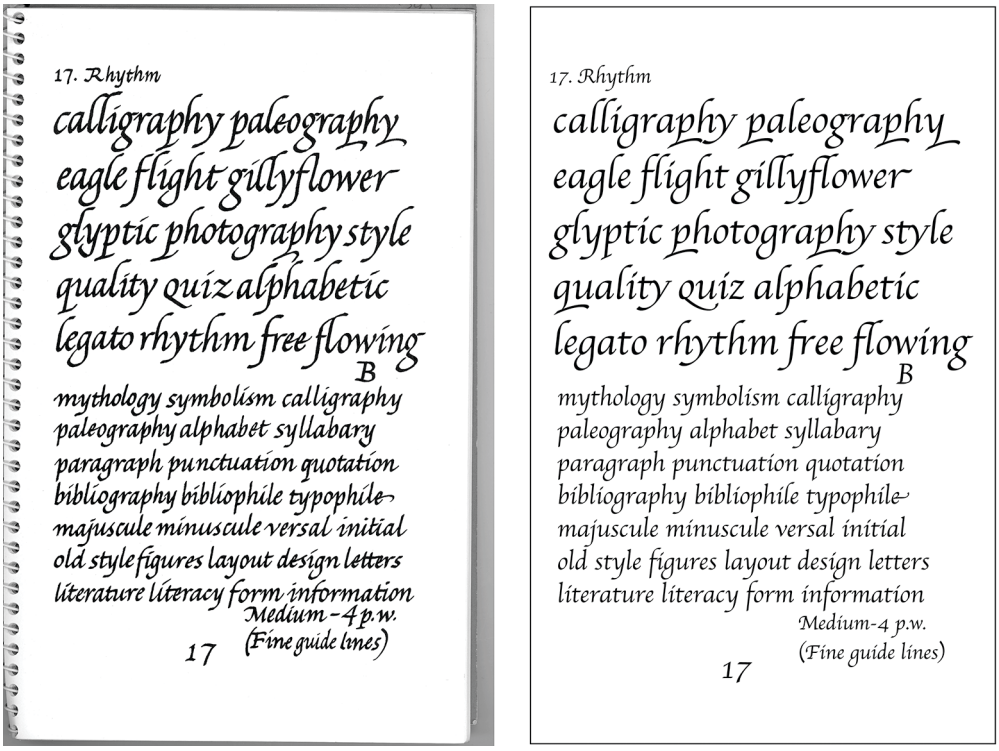


Figure 17. "17. Rhythm." Left page: Lloyd Reynolds' model book. Reynolds taught at Reed College where Charles Bigelow, Kris Holmes, and Steve Jobs studied. Right page: Apple Chancery, designed by Kris Holmes to express Reynolds' style of Italic handwriting as digital type.

Figure 18. Lucida Handwriting's connections emphasized over 16 weights, outlined.

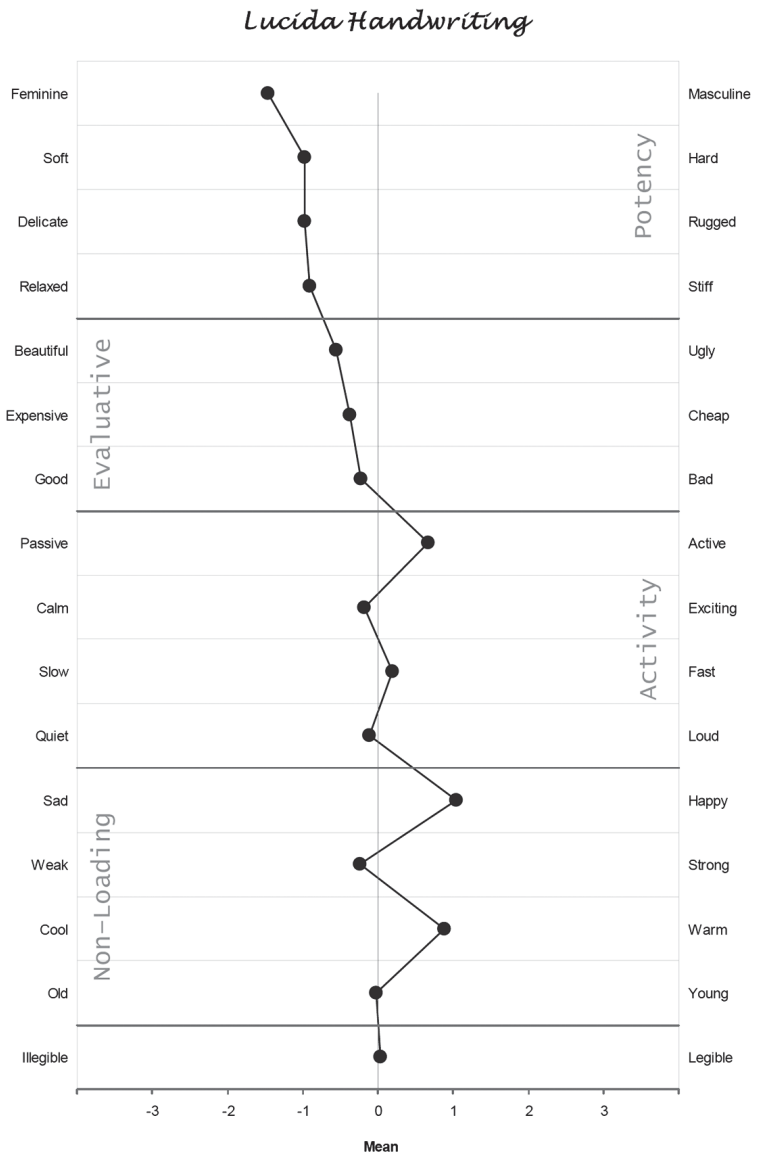


Figure 19. Lucida Handwriting analyzed in a Ph.D. dissertation by Audrey Dawn Shaikh at Wichita State University (Shaikh, 2007). The analysis is by a "semantic differential" psychology survey in which viewers note meanings, connotations, and feelings evoked by a typeface. Prior use of the semantic differential in typography was described by Wendt (1968) in *The Journal of Typographic Research,* which Bigelow (the first author) first read in 1968 in Jack Stauffacher's studio as a teaching assistant. (*The Journal of Typographic Research* was soon to be renamed *Visible Language*.)

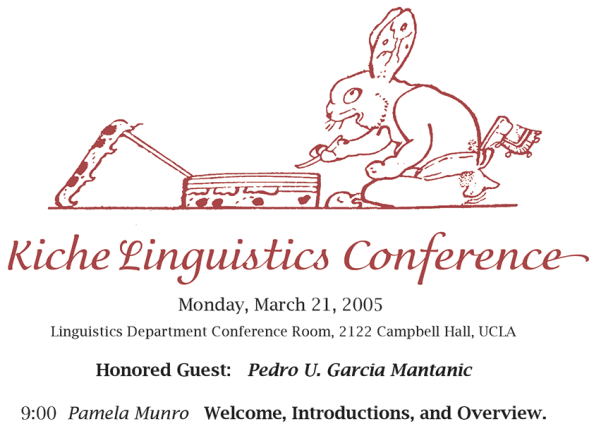


Figure 20. Program of a Kiche linguistics conference, its title composed in Kolibri. The image is a Mayan rabbit scribe painting a hieroglyphic book, bound in jaguar skin — the cutest scribe of all time. Text is Lucida Bright roman, italic, and bold.

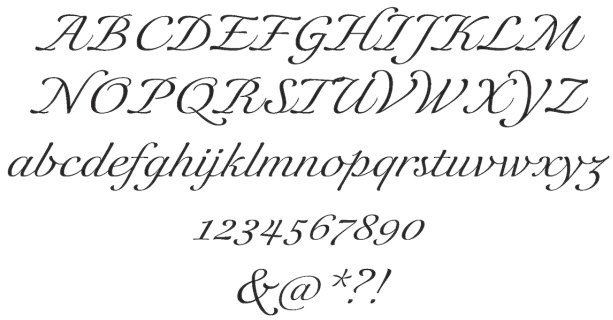


Figure 21. Fiorella light.

Figure 22. Lucida Casual in a gamut of weights.

Kolibri. Peter Karow, inventor of the IKARUS system, also invented a system that used context-sensitive letter variants with connecting joins at different heights, thus emulating the complex joining patterns of 18th century writing masters. Dr. Karow invited Holmes to design a script that followed his system, and she designed Kolibri for him and his firm, URW (Figure 20). The name comes from the Linnaean Latin name for the ruby-throated hummingbird, *Archilochus colubris* of Central America and the eastern United States. The hummingbird is a common character in Mayan mythology, and among other applications, Kolibri has been used in a program about the Kiche Mayan language. It was eventually produced by URW++ in the OpenType standard font format that enables context-sensitive letterform substitutions.

Fiorella. Fiorella is a cursive connecting script that adopts some of the subtle modulations of the Galileo typeface, but in a flowing, dynamic style. Holmes again used her joinery method from Lucida Handwriting, but Fiorella is an inclined, high-contrast style, like typefaces used in fashion advertising and elegant contexts, but with greater action and liveliness than is seen in strict cursive styles (Figure 21).

Lucida Casual. After we saw that Lucida Handwriting was popular following its release in 1992, we explored another direction, a semi-script text face that would have proportions and weights similar to the original Lucida, but that would be relaxed and curvilinear instead of rigid and rectilinear, like rapid handwriting with a partly worn felt-tip marker. The result was Lucida Casual in roman and italic styles, which was soon distributed with popular ink-jet printers by Hewlett Packard (Figure 22). Despite their modern origins, they evoked a distant echo of 15th century humanist fast handwriting with a worn nib.

Textile. Shortly after Lucida Casual appeared, Apple asked us to design a fun-loving all-curves font to contrast with the rigid, retro-futuristic look of Chicago, which signified Macintosh to many users because of its geometric-engineered insouciance. We were aware of every feature of Chicago because we had digitally constructed the TrueType outline version of it, using only straight lines and circular arcs, for Apple System 7 in 1990–1991. We felt that what Apple wanted was a sumo wrestler version of Lucida Casual, but Apple decreed that must fit into the same constrained metric space as Chicago. A daunting task, but we were inspired by a remark attributed to Mark Twain: “A round man cannot be expected to fit in a square hole right away. He must have time to modify his shape.” Hence, we took some time for Apple. The result was Textile — big, brawny, and bold (Figure 23). Apple no longer distributes it with MacOS, but it is still available as Lucida Marker.

2.9. Challenge 9: Mathematical Symbols

When we designed the first Lucida fonts, we designed mathematical symbols for them to be used with the TeX system invented by Stanford computer scientist Donald Knuth

Figure 23. Apple Textile (or Lucida Marker) on a vitamin package. After a typeface is launched, its designers cannot predict or control how it will be used — from computer operating system to vitamin box.

for composing mathematics. With TeX, Professor Knuth invented Metafont, a digital type system for developing fonts for mathematics, particularly the Computer Modern family that emulated Monotype's "Modern" fonts that had been used for typesetting mathematics in hot-metal composing machines for several decades.

Our goal was to provide a set of fonts in a different type style for TeX. To harmonize the mathematical characters with our original Lucida faces, we designed the mathematical fonts to be sturdy and resistant to noise in low-resolution printing and faxing. However, they were not intended for high-resolution book printing, and one editor called them "too aggressively legible." Taking that as guidance when we designed Lucida Bright for *Scientific American,* we "bright-ized" the Lucida Math fonts to harmonize with Lucida Bright alphabetic fonts. Microsoft released the bright versions along with other Lucida fonts in 1992, but the character encodings in that release made them difficult to use with TeX. Later, we reworked the character encodings, added more characters, and a small independent firm Y&Y produced them in PostScript Type 1 font format specifically for use with TeX in 1993.

In 2011, the TeX Users Group (TUG) asked us to make new versions of Lucida Math fonts for OpenType font technology and add more characters in the process. This we did, with help from TUG in producing the fonts (Figure 24). We took the opportunity to re-design some characters with different proportions and sizes. Our OpenType math fonts have been in use for more than a dozen years, while the older PostScript fonts have become technically obsolete.

There appears to be no end to the making of math fonts as long as there are creative mathematicians who think up new mathematical concepts that require new symbols. Therefore, from time to time, we are asked to add new or variant characters to our math fonts. It seems that the invention of new symbols has no end.

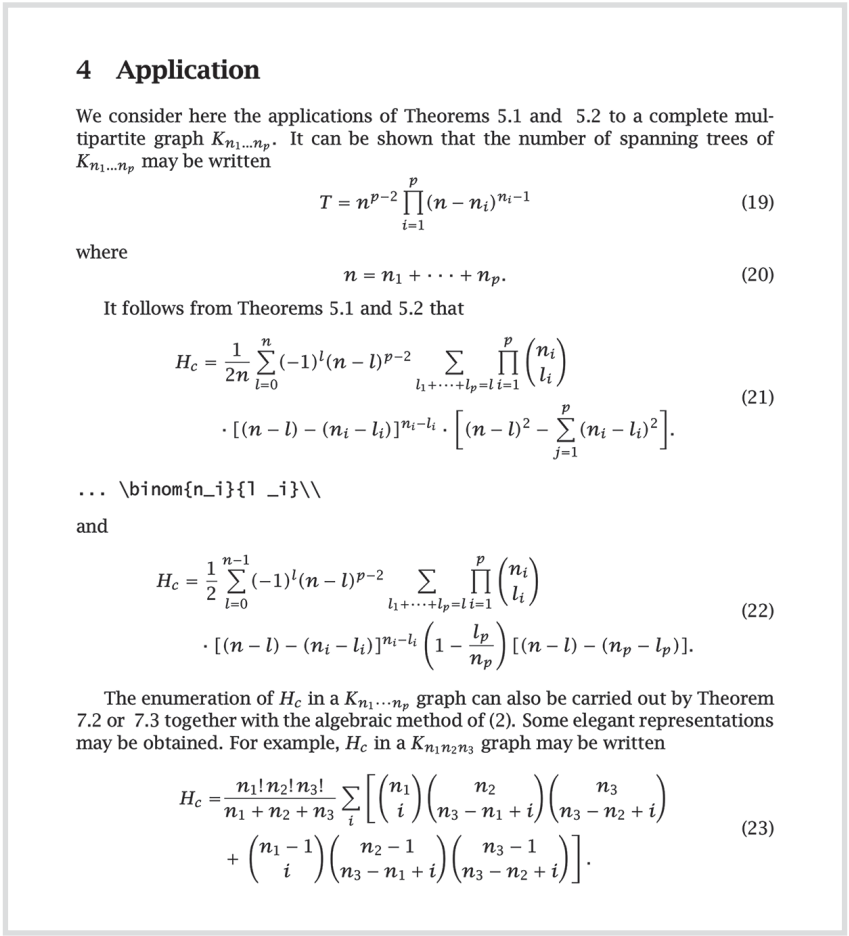
2.10. Challenge 10: A Reversal — From Low to High Resolution Fonts

In 1988, Apple Computer came to us with an unusual task. Instead of designing outline fonts like Lucida that technology can convert to legible bitmap fonts, they asked us to do the reverse: convert four of their bitmap "City" fonts from bitmap format to TrueType

outline format — the new, high-resolution outline font technology that Apple was developing (Figure 25).

The four low-resolution bitmap fonts, which had been designed by Susan Kare at Apple and were familiar to all Macintosh users, were Geneva, New York, Monaco, and Chicago. At 12 point on the Macintosh screen with a resolution of only 72 pixels per inch, those fonts were only 12 pixels in height, with an extra pixel or two for accents. Apple's TrueType font technology had a resolution of 2,048 possible points vertically and horizontally, so Apple was asking us to increase their bitmap fonts resolution by 150 times. Mere multiplication of size magnification was not appropriate because the result would be grotesquely blocky letters made of huge square pixel blocks instead of the smooth traditional letter shapes expected by readers.

What we did instead was deduce the kinds of high-resolution outline fonts from which those rudimentary bitmap fonts might have been rasterized. We thus inverted the *bottom-up* job into a *top-down* task by inference. Modern trackers and paleontologists



4 Application

We consider here the applications of Theorems 5.1 and 5.2 to a complete multipartite graph $K_{n_1 \cdots n_p}$. It can be shown that the number of spanning trees of $K_{n_1 \cdots n_p}$ may be written

$$T = n^{p-2} \prod_{i=1}^{p} (n - n_i)^{n_i - 1} \tag{19}$$

where

$$n = n_1 + \cdots + n_p. \tag{20}$$

It follows from Theorems 5.1 and 5.2 that

$$H_c = \frac{1}{2n} \sum_{l=0}^{n} (-1)^l (n-l)^{p-2} \sum_{l_1 + \cdots + l_p = l} \prod_{i=1}^{p} \binom{n_i}{l_i} \cdot [(n-l) - (n_i - l_i)]^{n_i - l_i} \cdot \left[(n-l)^2 - \sum_{j=1}^{p} (n_i - l_i)^2 \right]. \tag{21}$$

```
... \binom{n_i}{l _i}\\
```

and

$$H_c = \frac{1}{2} \sum_{l=0}^{n-1} (-1)^l (n-l)^{p-2} \sum_{l_1 + \cdots + l_p = l} \prod_{i=1}^{p} \binom{n_i}{l_i} \cdot [(n-l) - (n_i - l_i)]^{n_i - l_i} \left(1 - \frac{l_p}{n_p}\right) [(n-l) - (n_p - l_p)]. \tag{22}$$

The enumeration of H_c in a $K_{n_1 \cdots n_p}$ graph can also be carried out by Theorem 7.2 or 7.3 together with the algebraic method of (2). Some elegant representations may be obtained. For example, H_c in a $K_{n_1 n_2 n_3}$ graph may be written

$$H_c = \frac{n_1! n_2! n_3!}{n_1 + n_2 + n_3} \sum_{i} \left[\binom{n_1}{i} \binom{n_2}{n_3 - n_1 + i} \binom{n_3}{n_3 - n_2 + i} + \binom{n_1 - 1}{i} \binom{n_2 - 1}{n_3 - n_1 + i} \binom{n_3 - 1}{n_3 - n_2 + i} \right]. \tag{23}$$

Figure 24. Lucida Math demonstration, courtesy of the TeX Users Group.

Chicago
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

Geneva
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

New York
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

Monaco
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

Chicago
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

Geneva
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

New York
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

Monaco
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

Figure 25. A scan of the original Macintosh City fonts at 12 points, designed by Susan Kare (left), compared with the TrueType 24-point versions (right).

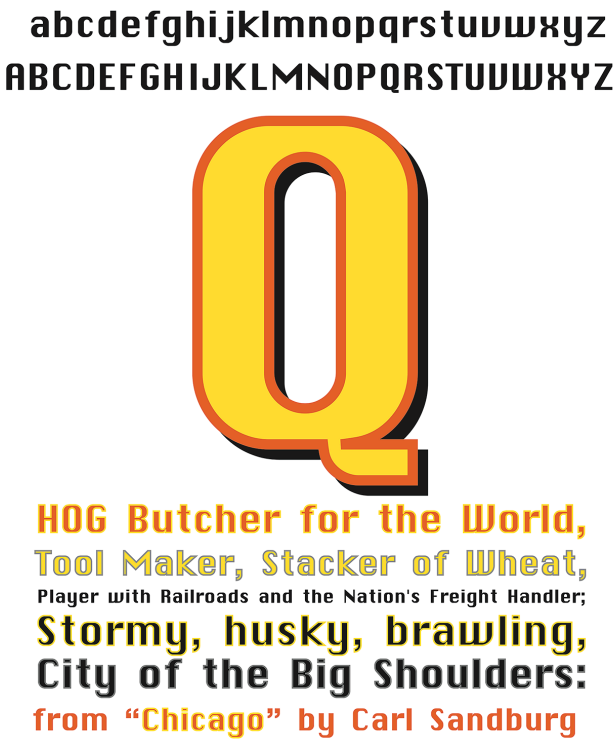


Figure 26. Chicago font in TrueType, 1991, showing its scalability, versatility, and color adaptability as a display face — no longer limited to a single size on the Macintosh screen.

do this when deducing what kind of animal left certain fossilized footprints. Semioticians might call it going from index to icon. Our task was complicated because each bitmap screen size was different in style and proportion, depending on Apple's original designer's visual intuition. Hence, we used statistics to estimate sizes, weights, and proportions. Moreover, none of the original bitmaps emulated a specific typeface. Generically, New York was serifed, Geneva was sans-serif, Monaco was monospaced sans-serif, and Chicago was bold condensed sans-serif (Bigelow & Holmes, 1991).

To avoid apparent changes in font size when used together at the same point size on the Macintosh, and to increase the number of pixels in the base forms, we made all x-heights proportionally large with equal ascender and descender lengths for New York, Geneva, and Monaco. We gave Chicago a larger x-height in keeping with its use as a headline face on the classical Macintosh screen (Figure 26). At high resolution, the faces took on clearer stylistic identities. New York looked like a mid-16th century French face, except with huge x-height. Geneva looked like a sans-serif grotesque in Swiss style. Monaco was a monospaced face with a slightly lively hieroglyphic look due to distinct serifs on letters "i," "j," and "l."

These four fonts were released in 1991 with Apple's then revolutionary System 7 operating system, which included TrueType font technology.

2.11. Challenge 11: Latin and Non-Latin Alphabets

Non-Latin scripts and writing systems were often difficult to adapt to traditional analog font technology. To Western eyes, not only were non-Latin character shapes novel and diverse, but their names and systematics were unfamiliar. Beginning in the 1980s, dedicated scholars and technologists have labored to devise and develop a single, universal standard for the computer encoding of characters for worldwide information exchange. The result of their decades of labor is the Unicode standard, now in its 16th edition and comprising some 155,000 characters and 170 scripts. The clarity and utility of the standard has enabled type designers to address issues of legibility, expressiveness, clarity, and style without also grappling with the fundamental issues of nomenclature and systematics that have been resolved and codified by Unicode.

Encoding as used here means the numerical identifiers by which computers denote characters. For instance, the capital "A" character in English and other Latin-based alphabets of Western European languages is identified as Unicode "code point" 0041, and lowercase "a" is 0061, in hexadecimal numbering. In ASCII, using decimal numbering, capital "A" is encoded as decimal 65 and lowercase "a" is decimal 97. What is important about a standard encoding is that someone can type the letter "A" on a computer keyboard in, say, Minneapolis, Minnesota, and it can be encoded in text transmitted over the internet through a series of different computer servers and systems and arrive

on the screen of a different brand of computer and operating system in Bangalore, India, and still be the letter "A." The same is now true for around 150,000 other characters standardized in Unicode, from English to Hindi to Chinese.

In 1989, Microsoft and Apple agreed on a new digital font format called TrueType, in which all characters would be encoded with the Unicode standard. The Lucida fonts in the Microsoft Font Pack for Windows released in 1992 were encoded with Unicode (Figure 27). The engineers at Microsoft then asked us to make a font that contained Latin plus non-Latin and symbol character sets, to demonstrate the power and flexibility of the TrueType font format. The result was based on Lucida Sans and was released as Lucida Sans Unicode in 1993. It contains around 1,725 letters and characters for the languages of Europe and the Americas that use the Latin alphabet, including deriva-

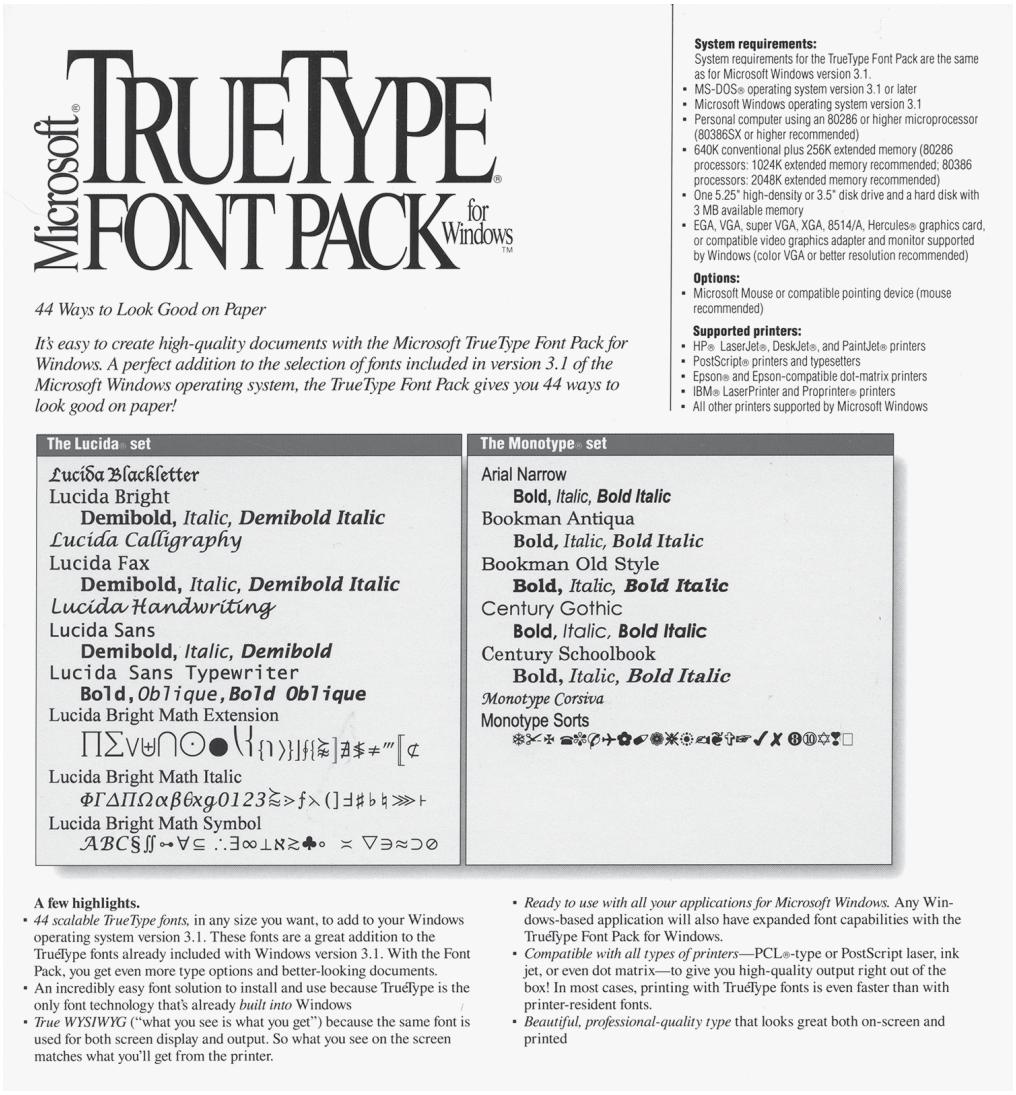


Figure 27. Twenty-two original Lucida digital typefaces designed by Bigelow & Holmes for the TrueType digital font technology invented by Apple and adopted by Microsoft.

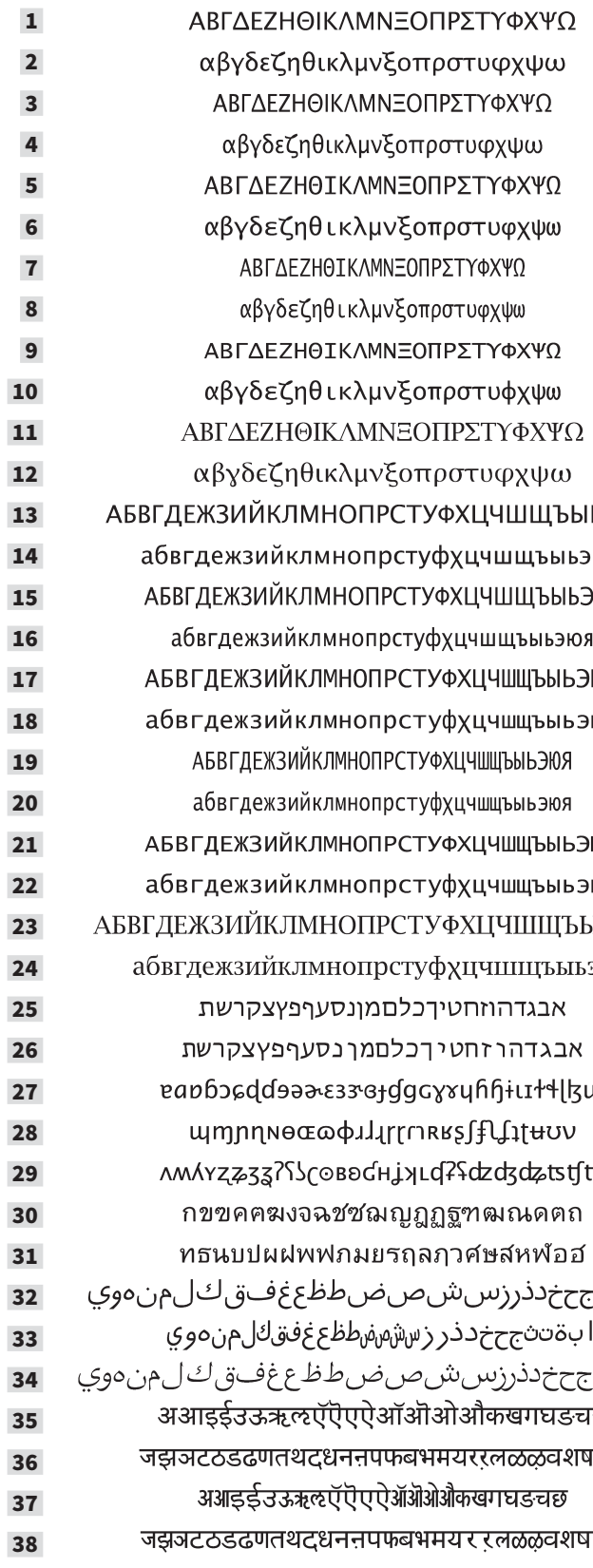


Figure 28. The authors' non-Latin typeface designs, showing only normal weights, in serif and sans-serif styles, and proportional and monospaced versions. Italics and bold weights have been omitted. Not all faces have all variants.

1–12. Greek (in pairs): sans-serif regular; sans-serif narrow; sans-serif monospaced; sans-serif monospaced narrow; sans-serif Console; serifed Bright.

13–24. Cyrillic (in pairs): sans-serif regular; sans-serif narrow; sans-serif monospaced; sans-serif monospaced narrow; sans-serif Console; serifed Bright.

25–26. Hebrew: sans-serif regular; sans-serif monospaced.

27–29. International Phonetic Alphabet (IPA), sans-serif.

30–31. Thai, sans-serif.

32–34. Arabic: sans-serif regular; sans-serif monospaced; Naskh (thick-thin).

35–38. Devanagari (Hindi, Sanskrit, other languages): sans-serif, proportional, and monospaced.

Figure 29. A sequence of still cells for an animated run cycle of an “H,” mapped against a similar run cycle for a human figure — from Kris Holmes’ lecture “Moving Right Along,” on the occasion of her receipt of the RIT Frederic W. Goudy Award in typography in 2012.

tives for languages of Africa, as well as letters for Greek, Cyrillic, and Hebrew writing systems, and for the International Phonetic Alphabet (Bigelow & Holmes, 1993).

Additionally, the font includes an extensive set of mathematical, graphical, and other signs and symbols. All were designed to have similar sizes, proportions, weights, and features, so that the disparate scripts and signs are united by a common, underlying graphical style. The non-Latin alphabets, like the Latin alphabets, were harmonized with Lucida Sans, not only for graphical harmony but also because of a long-standing belief by modernists in the 20th century that sans-serif designs can help neutralize features which otherwise may impede international communication, favoring some historical or cultural features over others. Although initially intended to show the benefits of TrueType and Unicode in 1993, it continues to be distributed with Windows operating systems.

Our subsequent work for Apple and other firms extended our designs of non-Latin typefaces to Greek, Cyrillic, Hebrew, Arabic, Devanagari (Hindi, Sanskrit), Thai, and International Phonetic (Figure 28). In 2000, we incorporated most of those non-Latin faces along with additional Latin and symbol characters into Lucida Grande, a pair of Unicode based TrueType fonts that Apple established as system fonts in the OS X operating system.

Non-latin monospaced, a retro-challenge. Although high-technology companies prefer to advertise progress, many of them require monospaced, typewriter-like fonts in operating systems and applications, so we were often asked to design monospaced versions of non-Latin typefaces to accompany or supplement our Latin monospaced fonts. Greek and Cyrillic monospaced alphabets are not only used alone. Our Lucida Grande Mono and Lucida Console fonts automatically include Greek and Cyrillic

monospaced alphabets, and we have also designed monospaced Arabic, Hebrew, and Devanagari fonts (Figure 28).

2.12. Challenge 12: Animated Fonts

The internet offers a surfeit of winking, blinking, and nodding letters that are trivial to produce and even less informative to witness, but in the golden age of American cartoons, animators often made letters look alive.

In an acceptance lecture for the Frederic W. Goudy Award at the RIT international symposium "Reading Digital," Holmes (the second author) spoke not of static but of dynamic typefaces. Using examples of her work and that of others, she demonstrated how digital technology and the internet enable type to enter a third dimension, not of space but of time, when letters come to life (Figure 29). She showed that typographic characters can be transformed in truly animated characters by using classic animation techniques including "squash and stretch," "anticipation and overshoot," "easy in, easy out," and self-writing script, among others, as seen in Looney Tunes and other classic cartoons.

"That's all, folks!"

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Authors

Charles Bigelow is a typographer, educator, MacArthur Prize Fellow, and RIT Goudy Award recipient, who has taught at Stanford, RIT, and RISD. He organized pioneering conferences on digital typography and reading science, and co-designed the Lucida typeface family. A former president of ATypI's Committee on Letterform Research, he holds degrees from Reed College and UCLA and studied with Lloyd Reynolds, Hermann Zapf, and Jack Stauffacher. He has consulted for Apple, Microsoft, and Adobe, among others.

Kris Holmes is a type designer, calligrapher, and animator known for co-creating the Lucida typeface family. She has designed over 300 typefaces, including Apple Chancery and Wingdings, and her work appears in *Scientific American* and in widely available Unicode fonts. A Goudy Award recipient, she studied with Hermann Zapf, Lloyd Reynolds, Robert Palladino, Edward Catich, and Ed Benguiat, and holds degrees from Harvard and UCLA. Her calligraphy is held in the Klingspor Museum and RIT's Cary Collection. She has taught at RISD, RIT, and University of the Arts, and she created the award-winning animated film *La Bloomba.*

INVITED ARTICLE

Towards Interdisciplinary: Juggling Similarities and Differences

Mary C. Dyson

Department of Typography and Graphic Communication, University of Reading, Reading, UK
(mary.dyson[at]reading.ac.uk)

Abstract: This (ashamedly) autobiographical account of my research career describes my journey from psychology to what might be described as psychotypography. A key aspect of the narrative is the means by which I sought to integrate into a design environment. I explore the notion of interdisciplinary research, an important feature of this journal, reflecting much of the current landscape of design education, research, and practice. The juggling of similarities and differences occurs at the level of disciplines and as part of my research methods. A common thread through most of the research is evaluating how people respond to visual material, to create findings that can be used in design practice and education. Broader implications are that many factors, within and outside our control, determine the course of research.

Keywords: design discipline; design research; interdisciplinary research; psychology; psychotypography; typographic design

1. Introduction

In reflecting on the research I have done under the broad umbrella of visual communication, I felt in need of a framework for organizing my thoughts. The one that came to mind was the 5W+H questions: why, when, who, what, where and how?* These

* I possibly chose this as I have used 4W+H questions in a 2017 chapter on information design research methods but I also like reading crime fiction and detectives are said to use this framework.

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questions provide a helpful context for understanding what can determine the research direction. The research outputs fall under "what" and are influenced by the other questions which overlap and interconnect, visualized in Figure 1. To summarize:

When:

- Early career, established career, or retired affected what I researched and who I worked with.
- The technology that was current at the time facilitated opportunities for research.

Who:

- Employing research assistants, through gaining funding, enabled empirical research.
- Collaborating with other researchers, when I was more established, allowed the crossing of discipline boundaries.

Where (interpreted as where the research was conducted and where it was published):

- The research environment created by my university and department provided direction on what to research.
- Choice of journals and conferences was determined by what I researched and my collaborators.
- Invitations to write chapters or give talks emerged when more established.

How (interpreted as how research was made possible and how it was carried out):

- Funding sometimes determined what is researched.
- Research methods that I used influenced where I published.

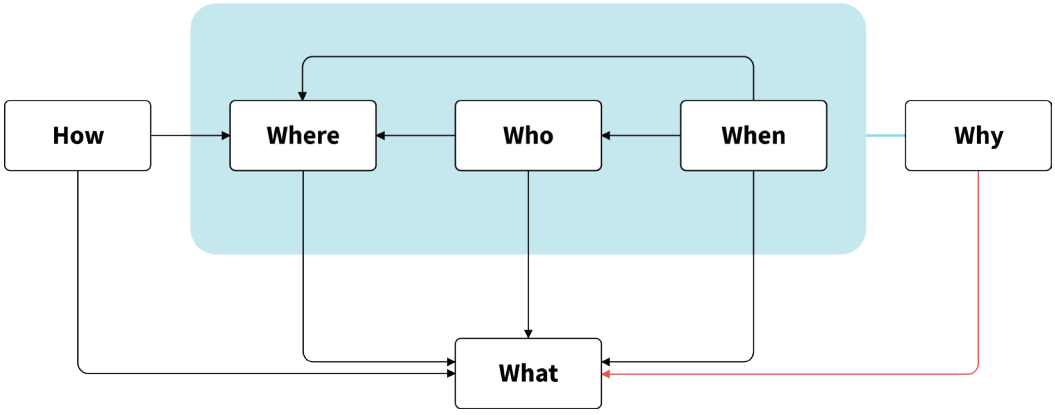

Figure 1. How the different questions relate to each other. "When," "who," and "where" (circled in blue) contribute to "why," as external factors; there is a direct link from "why" to "what" (red line) indicating my proposed motivations.

The 5W+H questions are answered in more detail within each of the themes described below. Some of the "when," "who," and "where" address "why" I did "what" I did. These are generic, external factors which would apply to anyone doing research in a university. In psychological terms, I appear to be describing the course of my research as directed by circumstances outside of my control, attributing the outcomes to situational factors.* Another way of answering the question "why," which enables me to take back some control, explores my personal motivations and ascribes the research journey to my disposition, rather than external circumstances. Both routes from "why" to "what" will be explored though there may be a bias towards my underlying motivations. I will start with unpacking the title of this paper.

1.1. Towards Interdisciplinary

I joined the Department of Typography & Graphic Communication at the University of Reading as a Lecturer in Electronic Publishing. With an education and training in experimental psychology, I needed to work out what was involved in visual/graphic communication, graphic design, typography. I began to perceive a large gap between psychologists' research interests and approaches and what designers consider important.

When I look back at my early attempts to integrate into a design environment, I am aided by some more recent reflections which drew on a report on *Facilitating Interdisciplinary Research* (2005) by the Institute of Medicine. This distinguishes among:

- Borrowing: use of one discipline's skills in another discipline.
- Multidisciplinary: separate contribution from each discipline.
- Interdisciplinary: integration and synthesis of ideas and methods.

Based on these distinctions, I deduce that I engaged in all three types of research. It is unsurprising that I was drawn to *Visible Language* with its emphasis on interdisciplinary thinking and relationships, which started with the objective of encouraging "scientific investigation of our alphabetic and related symbols" (Wrolstad, 1967, p. 3).

A theme that is repeated in various aspects of my research is interfacing disciplines. This has covered working with different groups of people — computer scientists, graphic artists, typographers, a museum keeper, an education assistant, and a learning technologist. I have also tried to address this explicitly by, for example, putting forward arguments for involving typographers in the design of human computer interfaces and exploring the contribution of information design to effective e-learning.

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* I am referring to attribution theory, developed within social psychology, a theory about how people "answer questions beginning with 'why?'" (Kelley, 1973, p. 107).

Figure 2. Word cloud based on 55 titles of written publications or conference presentations. Larger type size indicates higher frequency of use of that word.

1.2. Similarities and Differences

My research methods exploit similarities and differences. I prefer to do experimental studies measuring participants' performance whenever feasible, and these look for differences.* These comparisons are typically of variations in the test material but might also be between user groups.

Other methods I use include evaluating, analyzing, categorizing, and developing frameworks which involve the organization of ideas and looking for similarities and differences. When I conduct a literature review of empirical studies, I compare and contrast the methods used by the researchers and their results.

Given my methodological bias towards conducting experiments, I have also pointed out the limitations of guidelines that are not based on empirical research and are often derived from studies of paper-based materials and then applied to screen. This critique extended to craft knowledge gained from practical design experience of print, thereby drawing attention to the differences between psychological methods and design practice. I hope that I remedied this situation when I approached interdisciplinarity. Clearly, my integration was not seamless and included moving from pointing out differences between psychology and design to bridging the gap and looking for commonalities.†

* In scientific research we try to reject or disprove the null hypothesis by finding evidence to support an alternative hypothesis. If we find no differences, this might be because our method is not sufficiently sensitive to detect differences, so similarities are generally not informative.

† This gap between scientific research and design has also been discussed by designers (e.g., Bessemans, 2019).

Figure 3. Word cloud combining six titles, three of which are conference presentations. All raise questions or introduce a point of view related to crossing disciplines.

2. Themes

I have grouped my research into themes, which were not necessarily identified at the time but where I can now detect similarities. A word cloud* of titles of the publications and presentations hints at the grouping of themes but suggests my titles may not be sufficiently informative (Figure 2). However, I have persisted with this approach and generated word clouds within each theme.

Some of the studies belong in more than one theme through addressing two research questions. Other papers fit within one of the broad headings attached to the themes, but may not link with others, i.e., no neat progression of ideas within a theme. For example, the content of a conference paper may be inspired by the conference theme and should (at least marginally) be interesting for a live audience. Some of my reflections on cross-disciplinary issues come from conferences (Figure 3).

The order of themes is not strictly chronological as some themes include research conducted at discrete points in time and spread over some years, therefore overlapping with other themes (Figure 4). However, the order still reflects my career development and a move towards interdisciplinarity.

The themes are:

- Educational research in electronic media
- Human-computer interaction and interface design
- Legibility
- Fonts and reading

* Word clouds are visual representations of the frequency of words in a written text. They omit the function words. I created the word clouds in this paper using https://www.wordclouds.co.uk/.

- Legibility revisited | disfluency
- Characterizing perceptual expertise of designers

A brief description of some of the work within each theme follows, drawing on the framework of 5W+H questions.

2.1. Educational Research in Electronic Media

Shortly after I began teaching electronic publishing, the Apple Macintosh was launched and desktop publishing emerged in 1985. The term electronic publishing has come to mean publishing in a digital format, but its scope was rather broader in 1988 when the journal *Electronic Publishing – Origination, Dissemination and Design* (EPODD) was started. In keeping with this wider scope, I regarded digital typography as synonymous with electronic publishing and desktop publishing as a subset.

I was part of a team working on a funded project (DIDOT: Digitising and Designing of Type) which aimed to design, implement and evaluate a curriculum for digital typography for both computer-oriented specialists and graphic artists and typographers. This might be considered a generic curriculum, exploiting similarities, whilst also recognizing the need for interpreting the teaching material according to the orientation of the particular discipline (i.e., differentiation). The team naturally included representatives of these disciplines, although I did not fit easily into any of these fields. The approach was multidisciplinary, though some integration of ideas and methods occurred.

The release of HyperCard in 1987, a hypermedia system predating the WWW, enabled me to explore how students might be provided with alternative structures for organizing their knowledge of electronic publishing. I created a HyperCard based on my theory

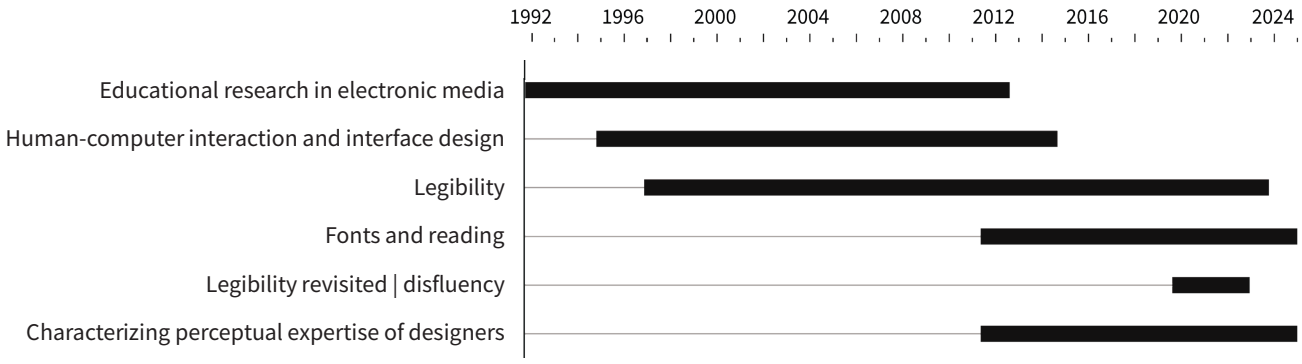

Figure 4. A Gantt chart illustrating the timespan and overlapping of themes.

Figure 5. Word cloud based on titles of eight articles and indicating my preference for exploring topics, perhaps due to an unfamiliarity with the areas. For this and subsequent word clouds (Figures 5–10), the reference sources are listed as appendices (Sections 5.1–5.6, respectively).

of electronic publishing lecture course.* This work is tied to the technology and user knowledge of the time and has little relevance to current practices but may have some theoretical value.

This denotes the beginning of my personal interest in interfacing disciplines, in this case, typography and computer science, and looking at the interaction between design and software. Some ten years later, virtual learning environments (VLEs) were topical, prompting my brief return to educational research through publishing with a PhD student and working with a learning technologist and a design researcher on a project evaluating a VLE (Blackboard) from students' perspectives.

The research topics are shown in Figure 5, which represents the titles of publications in journals or conference proceedings, some of which had a rather narrow focus (e.g., *Computers in Art and Design Education*). Some of the more recent work may have a minor legacy, for example, in providing guidance on "how to assess remote learning outcomes in virtual educational settings" (Fulcher et al., 2020, p. 951).

2.2. Human-Computer Interaction and Interface Design

This research field is an obvious candidate for interfacing disciplines under the umbrella of electronic publishing, as HCI is situated at the intersection of various disciplines which include psychology and design. However, there is little coherence in my topics as I approached this research area through different applications and from different angles, primarily determined by funded research projects. One project

* The most memorable feedback from students at the time was that they would prefer a printed artifact.

covered a possible graphical interface to a symbol database; two separate projects looked at computer-based systems in museums.

In the symbol research, the technology of the time (1992–1997) constrained the means of retrieving symbols based on the image, although neural networks were proposed for image retrieval (e.g., Rickman & Stonham, 1993). I worked with another psychologist as my research assistant and our approach was to involve students in Typography & Graphic Communication to sort, describe, and draw symbols to generate a classification system which formed the basis for a prototype interface to a symbol database. We published in a computing journal with an HCI angle.

The museum interface projects were both primarily evaluations of existing systems, but the projects were unrelated and involved different research teams. The first developed a framework for describing multimedia in museums which was published in the second issue of a new journal "set up in 1995 to address the creative, social, political and pedagogical issues raised by the advent of new media technologies" (Convergence, n.d.).

The second project conducted preparatory research evaluating web sites which provided access to museum collections. This was part of a larger project to make collections accessible through the WWW and required a range of skills and expertise. We considered this most suitable for a journal committed to research, analysis, and commentary on developments in museum practice. I also chose to highlight the interfacing of disciplines, describing the multidisciplinary team including the museum keeper, computer scientist, education assistant, content developer, and cataloger.

Two conference papers relate to interfaces but have no obvious relationship with the projects described above, although they may have informed my thinking. I proposed a simple framework for organizing empirical literature on navigation, divided into navigation strategies, structures, and tools. This slotted into an Information Design conference. Some ten years later, prompted by a masters student's interest and my personal frustration with inconsistent interfaces, we examined the interfaces to e-journal articles. Through an online survey, we were able to compare users' expectations of where standard features would be located and the observed locations. We were looking for differences and found them. This was a more mainstream conference for HCI: Design, User Experience and Usability (DUXU).

The Figure 6 word cloud highlights the more obvious terms within the theme, interfaces and users, whilst indicating that museum research played a significant role.

Figure 6. Based on the titles of six articles illustrating the emphasis on users and interfaces, and the museum context.

2.3. Legibility

In the twentieth century, legibility was researched from many different perspectives, for example: physicists (Luckiesh & Moss, 1942); a visual artist and a travel writer (Legros & Grant, 1916); a book artist (Zachrisson, 1965); and a graphic designer (Spencer, 1968). But the psychologist, Miles A. Tinker, was "the foremost American legibility researcher in the first half of the 20th century" (Bigelow, 2016, p. 167). This would therefore be another of the more obvious topics of research for a psychologist wishing to integrate into a typographic environment. There was also a good example set by the collaboration between psychologist James Hartley and typographer Peter Burnhill, conducting experimental studies of, for example, unjustified text (Hartley & Burnhill, 1971).

My route into legibility came through two research grants from Microsoft Corporation starting in the mid-1990s, which funded a series of experiments exploring the effect of typographic variables on reading from screen. Legibility of print (in particular, continuous text) had been sufficiently researched to provide guidance for designers. My previous experience with electronic media was helpful. At that time, research tended to compare reading from screen and paper (reviewed by Dillon, 1992). I chose not to look at fonts for screen display,* instead investigating text layout (line length and number of columns) and the mechanics of reading on screen (described as paging and scrolling). I sometimes expressed these variables as elements of interface design to fit within information science.

One outcome of our experiments was surprising and did not fit with print legibility findings and my typographic colleagues' practice of designing for print: there was an

* This was researched by Dan Boyarski, also funded by Microsoft Corporation (Boyarski et al., 1998).

Figure 7. Based on the titles of 11 publications, the focus of the research is quite clear.

indication that people can read a long line of 100 characters in a relatively efficient way, compared with very short lines. Importantly, a close colleague pointed out that they would not set continuous text in the way I had "designed" the test material.* If longer line lengths are used, additional space is inserted between lines. But I had deliberately not changed the interlinear spacing with different line lengths. I believe this prompted me to make explicit the differences between the disciplines. I found it difficult to reconcile my approach to experimental design with typographic practices.

I adopted a more constructive approach much later when Sofie Beier, a typeface designer, spent six months as a visiting researcher in the Department of Typography & Graphic Communication (October 2012 – April 2013). We were able to reconcile the conflicting demands of the two disciplines through Beier's work designing typefaces specifically for experiments. This led to joint publications and conference presentations describing our studies — multidisciplinary or perhaps even interdisciplinary research. Our research area also expanded, suggesting a more generic theme of fonts in reading.

A greater number of publications contribute to this theme and emphasize the main direction of my research (Figure 7). These spanned journals focused on computer-based applications, human-centered information technology, empirical research in reading, and visual communication.

2.4. Fonts and Reading

My primary aim within this theme was to clarify how readers deal with different fonts when reading (Figure 8). It is curious that I converted to investigating fonts as I was

* The scare quotes, signaling irony, are my addition and did not come from my colleague.

Figure 8. Based on the titles of 11 articles or conference presentations, a greater diversity of topics emerges and the overlap with the later theme incorporating expertise is apparent.

determined not to do so when starting to research screen legibility. A significant and very positive influence on my work came from Kevin Larson, a Principal Researcher on Microsoft's Advanced Reading Technologies team, a multidisciplinary team. His paper on the science of word recognition (Larson, 2005) made sense to me as he wrote from the perspective of a reading psychologist, yet appeared comfortable in the realm of typography.

A skilled reader can recognize most letters quickly regardless of the visual form, which can mean the font, case, or style of handwriting. Despite these differences in the visual forms of the same letter, readers can easily identify letters, recognizing them as representing the same character. The visual system creates abstract letter identities (Grainger et al., 2008). From differences in visual details, we look for similarities.

Having recognized that font information is generally ignored in psychologists' theories of letter and word recognition, I found and further explored research on a "font-regularity effect," originally demonstrated by Sanocki (1987). This describes our ability to recognize a sequence of letters faster if they are all in the same font, rather than different fonts — "font tuning." The effect was modeled and investigated through perceptual experiments in Sanocki (1987, 1988) and followed up by Gauthier et al. (2006) and Walker (2008), providing me with a topic that straddled disciplines.

In writing about font tuning, my objective was to engage with the two distinct readerships of typographic/graphic designers and reading researchers. I was, eventually, successful in publishing in a psychology journal, whose scope covers research in sensory processes, perception, attention, and psychophysics. However, I would not have achieved this without the help of the psychologist Thomas Sanocki. This collaboration positioned me in the design field, contrasting with Sanocki's theoretical and scientific expertise. Had I integrated too fully into my typographic environment? As

it was not very easy to prepare the research for acceptance by *The Design Journal*, I do not think I was fully integrated. There I aimed "to reconcile psychologists' and designers' approaches where possible, or identify differences that may enrich our understanding of how we read and how we may design letters to facilitate reading" (Dyson, 2013, p. 282).

By collaborating with a colleague, bilingual typographer Keith Tam, we were able to extend the study of font tuning to explore whether designers can perceive the stylistic regularity in a font when they cannot read the (Chinese) characters. Using the Chinese script, an ideographic system, was my first and only departure from a Latin-centric perspective, which I could not have attempted without someone with expert knowledge of the script. We found that design expertise does appear to facilitate the abstraction of the character shapes from the stylistic variations. Evidence of designers' perceptual abilities was accumulating (see the theme "characterizing perceptual expertise of designers" below).

The study of Chinese and Latin characters also addressed whether character processing is special, asking whether expert readers perceive letters in a different manner from shapes. I have been able to continue researching this topic, and others, collaborating with David Březina, a typeface designer and researcher. I have drawn on examples of research into areas of perception, both visual and auditory, which suggest how we might investigate visual forms. Březina has interpreted these theoretical notions and applied them to letterforms, developing online studies to test our hypotheses, a truly interdisciplinary perspective. These include asking whether the representation of a word in memory includes the font styling and whether we process letters holistically, meaning that we attend to all parts of a letter at the same time.

2.5. Legibility Revisited | Disfluency

In the midst of working on fonts and reading — and believing that I had moved on from legibility research — I was alerted to a study by Diemand-Yauman et al. (2011).* This presented empirical evidence for better recall of hard-to-read (disfluent) materials compared with easy-to-read (fluent) materials. This was followed some years later by the creation of a new font Sans Forgetica by Stephen Banham, which is intended to boost memory by being more difficult to read, though a "desirable difficulty" (The Guardian, 2018). Figure 9 illustrates the key terms emerging from articles stemming from conference presentations.

* The journal article was available online in 2010 and picked up by various media outlets, e.g., BBC News (22 October 2010). *Making things hard to read 'can boost learning.'* Retrieved 3 January 2025, from https://www.bbc.co.uk/news/world-11573666.

Figure 9. Based on five items, the disfluency theme is obvious.

I responded to these developments by searching for a flaw in the design of studies which supported better memory for harder-to-read fonts,* a conclusion that many of us would consider to be counterintuitive. This seems to be an example of my disconfirmation bias where "individuals will dismiss and discount empirical evidence that contradicts their initial views" (Lord et al., 1979, p. 2099). But how could I stand back when the tenets of legibility research and practice were being challenged? Of note was that there was seldom any reference to user-centered design or legibility research in the reports of disfluency experiments, the studies generally conducted by cognitive psychologists and educationalists.

However, the best way to challenge such results is to provide counter evidence. Teaming up with David Březina, we conducted our own experiment comparing Sans Forgetica and Arial. We found that Sans Forgetica is considered harder to read and slows down reading, but there is no difference in memory between the two fonts.

I also reviewed the literature on disfluency, and the various theoretical explanations, helpfully synthesized in a PhD thesis by Geller (2017). My underlying motive was to move the focus from a metacognitive effect to a perceptual effect, which I believe underlies legibility. The metacognitive explanation posits that the reader recognizes the word, perceives the word to be difficult to read, puts more effort into processing the word, and therefore remembers the word. This seems to ignore the perceptual process of letter and word recognition. A simple reason for the different explanations is that cognitive psychologists with a background in memory, reasoning, and other

* I was not alone in this as an apparent difficulty in replicating results prompted the publication of a special issue of the journal *Metacognition and Learning* (2016) exploring why the results might not be replicated.

higher-level processes will be more likely to focus on comprehension. Those with a background in perception research are more likely to focus on word recognition. I am in the second group. Differences clearly exist within disciplines, as well as between, especially in one as broad as psychology.

2.6. Characterizing Perceptual Expertise of Designers

I wrote in 2014: "As a teacher, I am interested in how we train students in the visual discriminations that are required of typographers and what characterizes typographic expertise" (Dyson, 2014, p. 1). The word cloud has captured this enquiry explored through five studies (Figure 10). The overlap with two previous themes comes from studies where we asked two research questions.

This questioning might appear to be a desire to separate typographers from others, conflicting with my desire to integrate disciplines. Because it comes quite late in my research journey, I believe it stems from a more informed perspective. This is definitely the case when collaborating on this work with David Březina.

The study of Chinese and Latin characters (described under the theme "fonts and reading") investigated both design expertise and reading expertise. Drawing on psychological theories, research on face perception has provided the inspiration for two further studies asking whether:

- Students with some education in typographic or graphic design perceive typefaces categorically.*
- Designers differ from non-designers in how they process letters, holistically or as separate features (also included in the fonts and reading theme).

Categorical perception is a psychophysical phenomenon whereby we perceive categories where none physically exist. I found some evidence that fonts are perceived categorically by people who have been trained to attend to differences among typefaces, but as I did not include non-typographers, we cannot be certain that they would not show this effect.†

Subsequent studies included a comparison of designers and non-designers, looking for differences.‡ Faces are considerably more difficult to recognize when inverted compared to other inverted objects or scenes. This effect has been attributed to the

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* Various aspects of face perception have demonstrated categorical perception (e.g., Campanella et al., 2003).

† Since readers need to decrease their sensitivity to differences that do not affect letter recognition (i.e., font styling), it is doubtful that they would show categorical perception of typefaces.

‡ In statistical terms, we are looking for an interaction between the method of processing (e.g., holistic) and expertise (designers vs. non-designers).

Figure 10. Based on eight titles and sharing two titles with the theme "fonts and reading" and two with "disfluency."

disruption of holistic processing (Farah et al., 1998). We examined whether an inversion effect is found with typefaces when discriminations are made by experts with type, compared with nonexperts. The prediction that designers would be less accurate when letters are inverted, whereas non-designers would have similar performance in both orientations, was confirmed. We proposed that designers learn to discriminate among typefaces by attending to the configural and holistic properties of the typefaces, the spatial relationships between parts, e.g., the positioning of thick and thin strokes. These are more difficult to process when inverted.

Research with art students has found less holistic processing of faces than ordinary observers attributed to art students' additional experience in drawing faces and attending to parts of a face (Zhou et al., 2012). Based on this finding, we predicted that designers, and in particular letter designers, might not process letters holistically, whereas non-designers would process letters holistically. This prediction contrasts with the inversion effect described above. Unfortunately, we found holistic processing of letters in both groups (designers and non-designers) but hypothesized that the two groups may have adopted different strategies which led to the same outcome.*

Having spent some time with designers, I am acutely aware of their sensitivity to bad design. How many typographers have given up reading a printed book because of the font used? In the experiment using Sans Forgetica described above, we explored whether we might be able to measure this sensitivity by comparing designers' subjective responses to the hard-to-read font (Sans Forgetica) with non-designers' responses. Designers judged that they would remember items they had read in Arial better than

* This is dangerously close to confirmation bias, interpreting in a way that better fits with our predictions. The hypothesis needs to be tested.

those in Sans Forgetica, whereas non-designers' judgments of memory were similar for the two fonts. Designers probably considered items in Sans Forgetica to be less memorable because they perceived them as less legible — the metacognitive effect. But there were no differences between the two groups in how well items were actually remembered.

3. Concluding Remarks

In my early career, moving into a new discipline led to my educational research in electronic media and some of the HCI projects. It was also a time when there was enormous scope for exploring the use of technology in art and design. Cross-disciplinary or multidisciplinary research is a natural response to these circumstances. But despite the existence of journals and conferences which encourage interdisciplinary research, there tends to be a primary discipline. Many of my articles or chapters were not in mainstream design publications. The most significant influence on my research is, without doubt, the people I have worked with. Almost every person who assisted me with research provided me with excellent support. Their funding was tied to a specific project, which meant some constraints on what we researched. When I moved into research collaborations, I believe there was a qualitative difference in the research and greater flexibility in what we researched. This could only happen when my research career was more established.

The juggling of similarities and differences is a natural feature of most research methods and was only a problem when looking for differences within an experiment and finding none. But the discipline difference was more challenging. Thankfully, the use of scientific methods in typography is common and frequently instigated by designers. They are in a strong position to anticipate their fellow designers' critiques, as not all agree with the experimental approach, and they avoid the pitfalls by generating ecologically valid findings.* I gradually learned what responses to expect, primarily from feedback on my conference presentations, but still feel more confident alongside a collaborator.

What is now my discipline, perhaps psychotypography, were it to exist? To my surprise, this field has already been proposed (Hyndman, n.d.), but I am interpreting the term in a different way to fit with my research: *Psychotypography is concerned with the perception of visual material, primarily textual, by readers and designers, combining the study of how we read with the visual attributes of what we read.*

* Results that can be generalized to real-world settings.

An important element of this combination is appreciating that psychology and typography address different questions: how we read versus what we read.

My route to psychotypography began with using methods from psychology, looking at readers' responses to typographic materials, for example, reading speed, comprehension, subjective judgments. I consider most of this research to be borrowing psychology's methods to use within typography. Some of the projects were patently multidisciplinary, combining with people from areas within and beyond design (e.g., computer science, museums, learning, and education). I could not have achieved interdisciplinary research without collaborators from within typography, and particularly type designers. However, my full integration required that I apply psychological theory to typography, not just importing methods. I hope I have achieved this.

How might this personal account be relevant to current researchers and designers in the field of visual communication? I am minded to leave this for the reader to consider whilst encouraging the very positive benefits of engaging with other disciplines.

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Author

Mary Dyson started by studying experimental psychology with a PhD in perception. She then moved into the Department of Typography & Graphic Communication, University of Reading, UK, teaching and researching theoretical and empirical approaches to typography and graphic communication. After retiring from her full-time position in Typography & Graphic Communication, she has written a textbook on legibility and has found time to reflect on her academic career and question some of her own assumptions. She is also enjoying developing scholarly collaborations with former students, colleagues and friends, and is currently Senior Visiting Research Fellow in the School of Arts and Communication Design, University of Reading.

INVITED ARTICLE

Nineteen Questions to Evaluate Typographic Research: Chaff and Wheat

Karel van der Waarde [a] and **Myra Thiessen** [b]

a Graphic Design – Research, Elewijt, Belgium; and Lucerne University of Applied Sciences and Arts, Lucerne, Switzerland; b Art, Design, and Architecture, Monash University, Melbourne, Australia

Corresponding author: Karel van der Waarde (waarde[at]glo.be)

Abstract: The number of experiments that investigate the "readability" or "legibility" of texts is very substantial. Literature reviews of these studies appear regularly, and many publications refer to these experiments to suggest evidence for claims. Some of these claims have led to usable recommendations. However, most of these recommendations are often hard to apply and unhelpful. When we are teaching typography, we struggled to explain why the recommendations are difficult to use, why many reviews are uncritical, and why experiments rarely provide reliable evidence to support design decisions. A literature review, guided by experience in both commercial practice and university level education, lead to a list of themes and issues. There are at least 19 reasons why the results of many typographic experiments need to be questioned. This article provides 19 guidelines that could be used to evaluate experimental research into the ways in which texts are read. This list of reasons can be used as a checklist to assess and guide new typographic experiments. We hope to make sure experiments are worthwhile, future reviews are based on reliable sources, and recommendations are effective.

Implications for practice: There are three practical applications of the findings of this review. Firstly, the 19 guidelines might help to critically review experimental findings and assess if they are relevant for practice — Table 1 is a handy checklist for this assessment. Secondly, the review shows that a typographic practice must be reader-focused. It is essential to involve readers throughout design processes, especially when the intention of information is to enable people to act. Performance criteria, evaluation methods and performance levels need to be relevant for readers. The result of this involvement is qualitative: a single remark from a single person can change the frame of a design project. And thirdly, the review shows that it is beneficial to look more intentionally at differences across readers and across reading activities. Involving people with

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Visible Language Consortium:
University of Leeds (UK)
University of Cincinnati (USA)
North Carolina State University (USA)

different backgrounds and experiences will provide new insights into the ways visual information can be interpreted and applied. Listening and observing are fundamental design skills that need to be trained and honed. Even after decades of practice, it remains a humbling experience to find out how people really look at visual design.

Keywords: legibility; readability; research methods; typographic research; typography

1. Legibility and Readability Research: Some Starting Questions

Typographic research investigates the ways in which the visual format of a text affects how people read and understand a text. These experiments are usually classified as "legibility research" or "readability research." Although several attempts have been made to clearly separate "legibility research" from "readability research," these terms remain opaque (Luna, 2018; Gonzales Crisp, 2012). Reading is a complex activity that starts from recognizing individual letterforms and word shapes and ends with the conscious interpretation of continuous text. In this article, we group all experiments that investigate relations between visual texts and the reading activities under a more general "typographic research." We focus on the Latin script because most of the research has used test materials with this alphabet.

This article only includes those experiments where people were asked to read a specific text. Experiments without actual readers, such as the research for "readability formulae" (Dubay, 2004) or other "expert evaluations" (Schriver, 1997) are not included. Furthermore, the focus is on "continuous text," and not on the letterforms of individual characters (Bigelow, 2016).

In our practices, we noticed the following:

1. Teaching typography and providing typographic advice that is based on evidence is difficult. The published recommendations somehow do not seem to be applicable (Gonzales Crisp, 2012; Schriver, 1997). This can hamper education and the status of the design profession, which might seem to some to prioritize craft skill and aesthetics over purpose and social outcome (Thiessen & Kelly, 2019; Frascara, 2022).
2. Reviews of the publications about typographic experiments, which is an integral part of any experimental study, keep referring to the same, sometimes outdated, experiments. These reviews rarely look critically at the relevance or applicability of the experiments they cite and take the outcomes for granted. This hampers new research.

3. Carefully applying the recommendations does not make texts more readable or more legible. Recommendations are often in conflict with each other, are not prioritized, ignore genres and readers, and do not specify a context or a language. This hampers practice and reduces the confidence in typographic research.

We look first at each of these three experiences. After that, we present 19 questions that might prevent some of the problematic repetitions in research, education, and practice.

1.1. Evidence for Typographic Decisions to Be Used in Education and Practice

In practice and in education, it is very difficult to apply any of the typographic recommendations outlined in research experiments. They require informed and specialized interpretation and often are not literal in a practical sense in that they cannot typically be applied universally.

Application in education. Students cannot apply the guidelines in their work and in observation they can find it difficult to understand why the information is important.

For example, co-author Thiessen draws regularly on scientific studies in her own typography studio teaching and thinks that studies such as Dyson and Haselgrove (2001) and Dyson (2004, 2013) are important examples to illustrate that reading actions and behaviors are different on screens compared to print media. Principles cannot be directly transposed from print to screens. Dyson and Haselgrove show that when reading from screens, readers can be quite proficient with line lengths up to 100 characters, which is substantially longer than the accepted 60–75 long believed to be ideal for printed materials. There are a few reasons that this may be the case, including issues surrounding reading distance, screen size and resolution, or paging/scrolling functions.*

However, in response to this discussion, Thiessen regularly sees progress work from students that contain line lengths in literal translation of Dyson and Haselgrove's results. In these cases, the application of "experimental results" in practical guidelines does not lead to the required results. It does not result in a text-design that is comfortable to read and that relates to the design of a genre. This observation points to an important gap in the teaching of typography. It suggests that students are lacking exposure to, first, rigorous typographic research publications and, second, the practice of doing scientific methods themselves to investigate typographic problems. These are both important skills for enabling capacities to question and test the function and accessibility of reading materials and developing a basic understanding of how to translate

* Technology has obviously progressed substantially since Dyson and Haselgrove published their study; however, we think this only makes our point here stronger.

an experiment's result for application. Typographic designers working in any range of professional practice would find value with these skills.

Application in practice by designers. It is common to hear phrases like "designers always have to 'break the rules' to make effective typographic designs" (Keedy, 1993). This can be misleading — or further, false — if the "rules" are not clearly defined, esoteric, or if there is no clear evidence supporting the so called "rule." It is worth looking at "best practice" to see which practical guidelines are recommended in particular contexts, but it is important to keep in mind or to question the reading condition the "rule" has been designed for. As mentioned above, reading on screens is proving to be very different from reading print based materials. So too are different environments, different reading actions, and different readers.

Functional reading (Thiessen et al., 2020) examines reading contexts including environmental factors such as lighting, stresses, distractions, awareness of the reader, and reader differences, to determine how to best support a particular reading action. If the guidelines are worth applying, then they should consider aspects of functional reading and be flexible and clear enough to respond to specific contexts. Similar arguments are made by Waller (2012), Moys (2017), Noël et al. (2019), and Larson and Picard (2005). They all attempt to make evidence-based design decisions and apply the recommendations, but the effects on readers do not seem to be directly related to the suggested generalizable outcomes.

For example, the recommendations that *line length, line space, and type size are directly related; if the line gets longer, more line space is needed; if the type size gets larger, more line space is needed* are repeated (e.g., Luna, 2018, p. 109; Spencer, 1968, p. 55), without mentioning in which context and in which kinds of genres for which kinds of reading, and for which kinds of readers the resulting text would be readable or legible. Van der Waarde (1999) shows that designers do divert from published rules, but clearly adhere to established visual patterns in novels, academic journals, and brochures.

Application in practice by non-designers. We think considering the non-designer is also important because some publications about typographic guidelines are read, cited, and used by people who are not trained to consider typography or scientific research — sometimes in ways that are worrying. For example, whether or not difficult to read, or disfluent, typefaces are valuable for learning has attracted attention in both typographic and cognitive psychology circles (Thiessen et al., 2020). A series of experiments were published assertively concluding that school age learners tested better when they were learning curriculum using reading materials set with difficult to read typefaces. What is worrying about this paper is that it suggested to teachers that presenting content in a way that is hard to read is a cost effective way to help their students learn more (Diemand-Yauman et al., 2011). Other examples have suggested that difficult to read

typefaces improve memory (RMIT, 2018). However, the problem of disfluency and its relationship to learning is far more complex. At best, there will be no effect, but if reading materials are hard to read, it is more likely that teachers reduce learners' motivation to engage with content or even impede learning outcomes for children who might struggle with reading (Astley et al., 2023).

Typographic solutions are rarely "one-size-fits-all," and it is essential to consider the consequences of poor guidance for non-typographers and to provide limits where the advice does not apply. It is therefore necessary that there is a clear link between the experimental data, the conclusions, and the recommendations. A "strength of evidence-scale," as it is used in the medical world (Jerkert, 2021), might be worth considering.

1.2. Uncritical Reviews

Some reviews and summaries that attempt to translate scientific research seem to uncritically quote experimental results and copy its advice and guidelines rather than contextualizing it for practical or educational application. These reviews tend to follow a tradition that draws on the same questionable experiments and repetitively extrapolate the same doubtful guidelines.

There seem to be three main reasons.

- *Reason 1: People ignore different research approaches.* It is important to note that there is a key difference in the way psychology and typography approach legibility research. This difference impacts the sort of research questions that are asked and how experiments are subsequently designed. Dyson (2013) helps by separating the aims of psychologists and typographers. Psychologists are primarily concerned with the mechanisms by which we read and the differences across people. These are "how questions." Typographers are more concerned with the materials used for reading, the environments in which reading actions take place, and the goal the reader aims to achieve. These are "what questions." Answers to the "how questions" explain why things happen. These do not suggest what to do to make things happen.

- *Reason 2: People do not question generalizations.* Reading activities and behaviors are contextual (Britt et al., 2022). This makes the replication of specific results more difficult across different kinds of readers, reading materials, and reading environments. It means that individual studies may only be able to tell us about very specific reading conditions. The outcomes of specific experiments cannot easily be directly translated into generalizable findings.

- *Reason 3: People do not question the reliability and validity.* In contrast with other academic disciplines, such as medical, pharmaceutical or educational

> psychology, experimental results are not always scrutinized thoroughly by typographers, and the link between experimental findings and generalized guidelines are not always carefully considered.

Reliable recommendations are based on experiments. These experiments need to be replicated. If the same test materials are used again in a similar context and study design, the same result must come out if they are to be trusted. For example, typographic practitioners have held onto the belief that the word-shape reading model is favored by fluent readers. The suggestion is that the activity of reading consists of recognizing the shape of whole words. This idea has a long history (Cattell, 1886). The most often cited article (Bouma, 1973) seemed to provide evidence, but a closer reading reveals that this is based on a misunderstanding (Larson, 2004). Experimental evidence does not support the word-shape reading model.

However, striving for reliability is still important to further our understanding of the performance of certain variables that might be important for a wider range of readers or conditions. Examples of these variables are motivations of readers (attention and interest), situations in which a text is read (stress, lighting), and availability of alternative information sources (practical validity). Understanding this distinction between "significant research results" and "reliable recommendations" makes critically evaluating legibility studies for typographic application even more important. A result in any given experiment might be significant, but if it cannot be replicated under similar conditions, the result is only meaningful to the circumstance in which it was created. This is not in itself very useful for furthering knowledge or understanding an effect but could point to something unique about the experiment itself. There might be an influencing factor that was not controlled for in the original experiment related to environment, material, context, or participant.

1.3. Generalization of Research Findings into Recommendations

One of the stark characteristics of typographic recommendations that are based on experimental studies in readability and legibility is that they have hardly changed since the first articles appeared about 140 years ago (Javal, 1878).

The reason why this is problematic is because reading is cultural, and the cultures of reading have changed substantially in this time. Readers and reading materials and behaviors are very different from those seen 140 years ago, with observed differences in how children develop reading skills. In some cases, children show a marked reduction in motivation and underdeveloped skills associated with deep reading (Wolf, 2018). Where once, reading was primarily a private and solitary act, it is now very public and permeates all parts of modern life. For some, communication by email or by text is preferred over face-to-face, telephone, or videophone conversation. These shifts in

reading behaviors have been enabled and shaped by changes to reading objects and environments. Where readers once relied on books and paper-pamphlets, they are now very likely using screens far more than printed materials. Furthermore, where reading may have been primarily an act undertaken for long periods of time, today readers may find they are expected to act or take action in response to a sign or label with only a few words or symbols. The introduction of the internet has also had a considerable effect on how readers engage with texts and their expectations related to both reading and content. As Carr (2010) explains, no longer is reading a "slow drip" of content for contemplation and integration with previous knowledge and experience. Rather, the internet has provided the means to access a flood of information, changing reading action from a substantiated task to something more akin to "skimming": seek and search. The result is readers who are less able to concentrate for long periods of time, and are now very practiced at darting around a text and picking up small snippets of information (Carr, 2010).

The aims of this article are:

- To prevent the repetition of uncritical citations and reviews by pointing out some of the issues. These comments might form a basis for further research.
- To reduce the attempts to apply unsupported recommendations ("rules") in education and in practice. The advice about typographic specifications that educators and researchers provide needs to be reliable and evidence based.
- To support practitioners with effective instructions and reliable advice about the visual design of texts.

Our ultimate aim is to examine norms in typographic research for their continued value. If research is conducted correctly, it is more likely that the resulting recommendations will lead to improved text-designs because they consider aspects related to functional reading and thus improve reading experiences and outcomes.

2. Nineteen Questions

The 19 questions we suggest below explore reasons why much legibility research that has been undertaken and reported needs to be reconsidered. Some are more serious than others, but they are all fairly damaging, in our view. We would like to stress that it is not our aim to list publications or shame authors who do this and have in other ways done very good work. Typographic research often seems to be based on questionable assumptions. These only come to light when many studies are compared, and patterns start to form. We did therefore not include the references to authors of reviews or recommendations who expected that the assumptions of previous researchers were correct. We may all be guilty of this at some stage in our research careers.

This list is not comprehensive. We raise these particular questions based on our observations and recognize our own interests and biases in them. However, it is our goal not to present definitive conclusions but to draw attention to what we see as a problem and, hopefully, incite some discussion and action that aims to improve the situation. In our opinion any of these 19 questions, in any combination, should place serious doubt on the validity of original data experiments in typography research.

The questions are grouped under five headings:

1. Participants,
2. Test materials,
3. Measurements and criteria,
4. The experiments,
5. Sources: authors and sponsors.

These themes were selected because each of these needs to be considered in the evaluation of an experimental study. They determine the accuracy, validity, and reliability of the results. Replication of an experiment is not really possible without an exact description of these five themes.

2.1. Participants

Question 1: Reading processes — Does the study describe the readers, conditions, and models? Reading is a complex cognitive activity. Models for how a reader can identify and comprehend letters and words were debated in early psychology literature (Cattell, 1886; Javal, 1878). However, it is relatively understood that readers mostly likely use a method of template matching where one uses specific letter features to identify letters (Grainger et al., 2008).

Experienced readers also likely rely on several strategies simultaneously during extended reading tasks including phoneme mapping to sound out unfamiliar word and semantic context to anticipate upcoming words (Dehaene, 2009). However, readers may differ dramatically and any reader who experiences any kind of difficulty or impairment that interferes or obstructs the reading process may not behave in expected ways.

Experiments that do not describe readers or reading conditions and any factors that deviate from what might be considered typical could be naively assuming that “all reading is equal” and that “all people read in an identical way.” For example, most experimental environments are relatively sterile set ups with good reading conditions. The experiment is conducted in well-lit rooms with little to no distraction unless it is part of the task and readers are fluent and are unlikely to have experienced a reading or language related difficulty such as dyslexia or aphasia.

If an experiment does not recognize reader differences and reading strategies that may be at play, be cautious.

Question 2: The starting point — What do we know about the participants? Was there a test beforehand, or some detailed description, that outlines the reading ability, existing knowledge, language skills, and motivation of participants? If not, discard the results. Without first understanding the reading level and capabilities of the readers that comprise participant groups it is impossible to know the extent that reading capabilities may differ. Reading is a learned skill that requires practice and maintenance, an individual who reads extended texts for three or more hours a day will likely read faster than someone who reads a lot less, reads infrequently, or reads primarily messages and e-mails (Suk, 2016). Readers will read new and more complex information slower than content they are familiar with (Schriver, 1997).

Readers who are marginalized for any reason do not typically form part of participant groups. Marginalized readers may have a different reading behavior due to dyslexia or compromised linguistic ability because they are reading in a second or third language (i.e., not their native language). Or they might have low vision, memory issues, or learning difficulties. These are not the groups of readers that typographic research is often most concerned about.

However, these capabilities are fundamental for functional typography. Typographers are designing texts for specific readers to support a specific reading task (entertainment, learning, searching, instruction) in a specific environment (library, home, café, public transport, driving). Readers may have any range of ability or disability, and these must be considered before results from experiments can be drawn.

Question 3: End points and aims — Is there a clear purpose for the person who reads? People read texts for different purposes: reading to do, reading to learn to do, reading to enjoy, reading to assess (Schriver, 1997). In these actions readers adopt different strategies such as skimming, scanning, slow careful reading, or searching (Muijselaar & de Jong, 2015). Ignoring these differences and not discussing the specific action, content, and context an experiment aims to support will likely invalidate the conclusions and make it very difficult to generalize the results and apply them in real world situations. No one reads a text for no reason at all; there is always a goal.

Question 4: Different people — Are the participants university students? Many experimental studies have been conducted on students in a university environment, most often psychology students. The underlying assumption is that this is a homogenous group. However, anyone who has ever taught a classroom of students knows that there are many differences within a group caused by motivation, experience, reading skills, and so on.

Psychology and related fields are desired programs of study, and they are therefore able to accept the brightest and most capable students from the range and applicants. This means that they are more typically skilled and experienced readers. And they often come from a certain position of privilege in society that has enabled them to enroll in a university program. Students may also be more practiced in experiments than more diversely represented participants since they are regularly recruited for experiments due to the nature of their program of study. Although not likely intended, this practice and lack of diversity may be perpetuating cultures of exclusivity and exclusion through the reading materials that are developed using these study results. It is furthermore unlikely that student populations can be compared over time or geographical locations. The reading behavior of students in the 1950s in the USA might not be comparable with the reading behavior of students in the 2020s in Australia.

These first four questions indicate that reading processes, starting points, aims, and participants vary. These questions need to be taken into account when experimental studies into the effects of the typography of reading materials is compared.

2.2. Test Materials

Question 5: Repeatability — Are the test materials available or is there an accurate visual representation? A verbal description of typography test materials is not sufficient, and it is impossible to evaluate the research if no accurate visual representation of what was tested is provided. It is also important to know how the material was finished. If it is meant to examine print materials, then dimensions, paper stock, and details of the print output are important if there is any hope of replication. For experiments that test onscreen reading a record of the type of screen, the resolution, colors, and sharpness should be documented. It is essential to record what participants looked at exactly during an experiment. Some test materials might have been archived, but many have been lost, deleted, or can only be shown on obsolete technology.

Question 6: Design of materials — If the test materials are shown, are they appropriate for the research question? Evaluate the test material to determine whether it is appropriately designed to address the research question. Many test materials have been criticized for poor design or because they use a typographic specification that would not occur in practice. However, it is important to understand that the material may be very effective for isolating a specific variable and in some cases, it is necessary to push the boundaries to investigate a hypothesis. When evaluating the appearance of test material, it is essential to consider if these materials address the research question. The design of reading material plays a very large role in how a reader interacts with it, as well as their capacity to perform any range of cognitive tasks (Walker, 2001).

In some cases, disciplinary differences play a role in how materials are reported and the value placed on their development. For example, a psychology researcher may be less concerned about the visual appearance and output criteria of test materials because their research questions tend to be framed around mechanisms that influence perception, behavior, or cognition. However, aspects of these mechanisms that are related to reader impression, motivation, and belief (Song & Schwartz, 2008, 2010), along with certain reading processes (Thiessen et al., 2022) are closely tied to the visual appearance of a text. This makes accurate reproductions of the materials important, especially in order to translate results for typographic practice.

Question 7: Boundaries — Are the recommendations generalized without any genre-limits? Research is often undertaken with type stimulus presented onscreen, but the results are often suggested for application across a range of print media with little critical evaluation of the likely differences in reading behavior media causes. Reading acts are different across reading materials because the reader's goals are different. Reading a newspaper differs from reading an online instruction because readers come to reading tasks with different expectations. Newspapers are designed to support a nonlinear reading strategy where the reader can scan headlines quickly and dip in and out of an article. Online instructions are designed for step-by-step reading and thus support a specific sequence of consecutive activities. Supporting different reading goals has led to different genres that are based on different typographic configurations (Moys, 2013). For example, the line length in a paper newspaper differs from the line length in an online instruction because the reading strategy employed by readers engaging with these materials is different. To suggest that there are "optimal factors" that can be applied across reading objects and tasks disregards the differences between genres and is not supportive of a variation of reading strategies.

Question 8: Language characteristics — Is the language, alphabet, and/or writing system defined and its unique characteristics described? It is common to assume experiments have been undertaken in English, or that what is appropriate for English will also work for other languages. This is not the case. Word length can vary dramatically across languages, and this may influence optimal line length and necessary line space. Avoiding hyphenation is a common recommendation for typesetting English but this could be far more problematic for Dutch, Danish, or Finnish where words, on average, have more characters. Plus, the use of diacritical marks and accents can also influence reading. Because of the discernability of diacritical marks, it is necessary to design texts in French with more vertical space and a slightly larger x-height than texts in Dutch. Data collected using Latin script is not likely to extrapolate to languages using other scripts such as Greek, Hebrew, or Cyrillic, or to scripts like Arabic, and languages that use characters like Korean, Japanese, or Chinese languages. There is no one-size-fits-all solution to typographic design across languages or scripts.

Question 9: External validity — Does the study deal with realistic looking texts and/or realistic reading scenarios? Test materials that are used in typographic experiments must be directly related to practical uses. The less realistic it is, the less it can speak to functional reading scenarios. Materials that are designed to more closely replicate realistic reading material can speak more broadly about reading behaviors and performance based on typographic variables. For example, texts need to be read under pressure because the reader is on a motorway and searching for specific instructions, they may be reading under low lighting conditions, or they may be reading from a backlit device. We still lack sufficient knowledge about the impact of environmental factors more broadly and the various distractions a reader engaged in continuous reading actions may encounter at any one time on their reading and cognition.

This is not to say that studies that evaluate how readers are able to identify letters or words in isolation are not valuable. These studies can tell us a great deal about legibility (Beier, 2012), how letters are identified (Pelli et al., 2006), how word reading is impacted by environmental visual noise (Sawyer et al., 2020), and how cognitively demanding the process of reading is (Thiessen et al., 2015). However, this is only one piece in the puzzle and these studies are limited if the results have not been tested for reliability under more realistic reading conditions.

Question 10: Variables — Is the combination of typographic factors described? It is usually acknowledged that it is "a combination of typographic factors" that makes a text legible. These combinations include factors such as typeface, type size, line-space, line length, color, and type-weight. Usually, these individual factors are described without reference to each other. Just investigating a single variable, without acknowledging the interactions between these variables, invalidates many typographic studies.

Very few publications bother to describe the non-tested typographic factors, such as the paper quality, the dimensions of the margins, the dimensions of the paper, or the characteristics of screens, all of which contribute to functional readability.

Question 11: Date of studies — Does the study rely either moderately or heavily on old or outdated science? As mentioned above, cultures of reading change over time and this means that scientific studies undertaken more than 20 years ago* will not be able to inform typography today. Unfortunately, it is common to see work from before 1950 turn up in reference lists. These studies were limited for reasons related to technology, such as a limited capacity to modify type sizes without very time consuming and costly type-setting compositions. This along with the shifts in reading cultures seen since these early works make it difficult to see how knowledge about reading behavior and reading materials produced using letterpress will be able to satisfactorily inform

* Twenty years is even a generous timeframe in our opinion.

typographic design output with modern offset or digital presses. Even more worrying is to think those historical studies can inform screen reading.

Technological advances have also been instrumental in how reading and reading materials have evolved. Consider how mobile technology has changed the way readers engage in reading acts and how their expectations for how information is delivered has changed — and this can be observed over a very short period of time, relatively speaking. Historically, reading acts, typographic preferences, and what readers will tolerate has changed very slowly, but it has changed. As the mechanics for developing texts changes so do the materials that are developed, and readers change in response.

This means that experiments that examine a reader's response using test stimuli that is no longer relevant are not useful for typographic design today, nor will they say anything about contemporary readers.

In conclusion, these seven questions about typographic experimental materials indicate that it is essential to look at the original test materials, genres, scripts, practical validity, combinations of typographic variables, and reproduction technologies. Again, the variation of these factors in the literature is substantial, and it is unlikely that generalizable conclusions across these factors can be drawn.

2.3. Measurements and Criteria

Question 12: Measurement units — Is the type size specified in points? If the answer is yes and different typefaces are being compared, the results and recommendations are not usable. "Point sizes" are not directly related to the vertical dimension of printed letters, not in print nor on screens.

Every character in the Latin script is contained in a rectangle. A designer of a typeface can choose the vertical dimension of each character within this rectangle, as long as all characters are positioned on the same baseline. A second complicating factor is that the actual dimensions of "a single point" have changed several times (Boag, 1996). The points that we use at the moment are PostScript points. Although the difference might seem small, it is significant because there is no guarantee that the dimensions are kept identical in this conversion. Even as a plain description as "12 point Times New Roman" does not give an exact dimension. Which points? Which "Times New Roman"? Which technology?

The combination of these variations in typefaces and point sizes makes it impossible to estimate the size of the type used in experiments or recommendations. Type size is an influential variable in typographic research, and comparing different fonts at the same point size will not result in useful data.

Question 13: Appreciation — Is aesthetic preference considered? A reader's preference for particular presentations of information do not always correlate with their capacity to use them (Wright, 1979), and the impact of preference for typography is seen from the first stages of reading development (Thiessen & Dyson, 2009; Walker & Reynolds, 2003). Although aesthetic preference may not factor into reading performance, it has shown to be influential in capturing attention, influencing motivation, and affecting the mood of the reader (Larson, 2007). One cannot lose sight of how influential motivation is on reading acts and that motivation is closely tied to aesthetic preference. If a reader does not want to read something because they do not like it, they will not read it.

Question 14: Reading measure — Is "the speed of reading" really an appropriate measure? Unless the differences are substantial, readers are unlikely to care about, or even notice, differences in their reading rate. However, in a typographic experiment, changes in reading rate can suggest particular typefaces or typographic arrangements are easier or harder to read. For example, disfluent typefaces are likely to slow down reading due to their visual complexity (Thiessen et al., 2020). This means that readers may need to exert more cognitive energy to perform simple tasks related to letter and word identification. Since the working memory is limited in capacity this means that the reader could struggle to perform higher-order tasks necessary to interpret and assimilate the content they are reading (Thiessen et al., 2015), which is an undesirable outcome for the reader. So, while a reader may be unconcerned with small changes in their reading speed, this can provide a way to identify and improve factors affecting reading efficiency.

However, reading speed as an isolated measure is not likely to provide a very clear picture about performance and is not sufficient to evaluate typographic design. If this is the only measure and it is uncontextualized, approach with caution.

In conclusion, selecting appropriate dimensions and criteria in typographic experimental research has proven to be challenging. Traditional point sizes are not reliable, aesthetic preferences are hard to determine, and criteria such as reading speed are hardly relevant for readers.

2.4. The Experiments

Question 15: Context — Is the experiment related to reading in real life situations? When drawing on experimental research to inform typographic practice it is important to understand that each study can only speak to one narrow set of variables, and that the study must be tightly controlled to eliminate any distractions or unintentional effects. In order to achieve this, many studies take place in laboratory settings and bear very little resemblance to environments in which texts are normally read. Laboratory settings are important to ensure that measurements are accurate and able to address

the intended variable manipulation. It is clear that scientific methods have been able to tell us a great deal about people and reading behaviors. However, these methods are limited in their capacity to examine reading in real life situations. The environments in which people normally read are riddled with distractions that affect attention and comprehension.

A successful typographic experiment is one that considers functional readability (Thiessen et al., 2020) and aims to create more ideal reading scenarios through the combination and evaluation of the science, craft skill, reading environment, and reader goal. For example, will there likely be noise, poor lighting conditions (you do not want to keep your partner awake), painful reading positions (not enough pillows, poorly designed sofas), or environmental distractions (children, television, colleagues)? Data generated in laboratory settings can only speak to isolated factors and only speculate about specific aspects related to functional legibility. The best way to understand how typography functions in a broader sense is through combined laboratory and real-world evaluation.

Question 16: Global standard — Does the experiment aim for a gold standard? Is the aim of a series of experiments to find a "gold standard"? The assumption that it is possible to find an ideal combination of typographic variables that is effective across different contexts is incorrect. It is a fallacy. Reading depends on the combination of a text (visual material), a reader (eyesight, background knowledge, aims, intentions, linguistic knowledge), and a situation (late at night, on a beach, in a train, in an office). Examining only text variables ignores functional reading principles and will not lead to more usable typographic outcomes.

Question 17: Impact — Do the authors overclaim impact? When undertaking research, one typically has vision for how the work might expand or in what contexts it may be translated and applied. However, it is important to represent results accurately and avoid inflating the importance of individual or isolated experiments.* As we have seen in the points above, typography is a complex and dynamic system of interconnected variables and readers are individual cases with unique challenges and gifts. Claims about easy fixes or that altering single variables, like a typeface, are effective are likely to be untrue.

In conclusion, the context in which typographic experiments are conducted affects its results. Conclusions drawn from data in specific contexts are unlikely to be generalizable or have a similar impact in another context.

* We recognize that bodies of work that have been developed over long and focused careers have impacted the fields of legibility, perception, and typography in profound ways (for example, Denis Pelli or Gordon Legge). This is not the work we allude to here.

2.5. Sources: Authors and Sponsors

Question 18: Credibility — Are the sources credible? Uncritically accepting everything that has appeared in academic journals without checking might lead to the wrong conclusions. A prime example are the publications by Prof. Dr. Sir Cyril Burt (e.g., Burt, 1959). Although he published in the most prestigious journals and with respected publishers, his typographic experiments were discredited. There is simply very little truth in Burt's work in typography (Hartley & Rooum, 1983). Since this work proved to be fraudulent and of no value, articles that quote it as valid typographic guidance are called into question for their rigor, accuracy, and validity. A more recent example can be seen in the debate surrounding the typeface Sans Forgetica, which saw claims suggesting that using the font would improve memory by drawing on the principle of desired difficulty (RMIT, 2018). Details of the experiments undertaken by the font researchers and developers are not published to our knowledge and subsequent studies have not been able to replicate the same effect (Geller et al., 2020; Huff et al., 2022).

Referring to disproven claims shows limited engagement with the academic debate in typography and psychology and is simply bad academic practice.

Question 19: Sponsor — Who paid for the experiments? One of the important influential factors is the sponsor of the research. It is always worth asking who paid the researchers, who paid the participants, and who will benefit from the publication of the results. Legibility research paid for by Microsoft in 1996 and undertaken by Carnegie Mellon University concluded that screen fonts Georgia and Verdana — which were specifically designed for Microsoft — were more legible on screens than Times New Roman (Boyarski et al., 1996). Is it likely that any other result would have been published? Although it is not very common in legibility/typographic research, it is an important question to ask, nonetheless.

In conclusion, a check of the authors and their sponsors might reveal reasons to critically reconsider the outcomes of typographic experiments.

3. Discussion: What Can We Learn?

Based on the previous 19 questions (reiterated in Table 1), we propose two recommendations for typographic practice and research and see these as opportunities to move forward and strive to achieve conditions grounded in principles of functional readability (Thiessen et al., 2020).

First, in opportunities that allow it, adopting a typographic practice that is reader focused and works to integrate the processes of writing, designing, and testing is more likely to result in texts that are suitable for specific readers and support them through

Table 1. Nineteen questions for evaluating typographic research, with two recommendations.

Participants	1	Reading processes	Does the study describe the readers, conditions, and models?
	2	The starting point	What do we know about the participants?
	3	End points and aims	Is there a clear purpose for the person who reads?
	4	Different people	Are the participants university students?
Test materials	5	Repeatability	Are the test materials available or is there an accurate visual representation?
	6	Design of materials	If the test materials are shown, are they appropriate for the research question?
	7	Boundaries	Are the recommendations generalized without any genre-limits?
	8	Language characteristics	Is the language, alphabet, and/or writing system defined and its unique characteristics described?
	9	External validity	Does the study deal with realistic looking texts and/or realistic reading scenarios?
	10	Variables	Is the combination of typographic factors described?
	11	Date of studies	Does the study rely either moderately or heavily on old or outdated science?
Measurements and criteria	12	Measurement units	Is the type size specified in points?
	13	Appreciation	Is aesthetic preference considered?
	14	Reading measure	Is “the speed of reading” really an appropriate measure?
The experiments	15	Context	Is the experiment related to reading in real life situations?
	16	Global standard	Does the experiment aim for a gold standard?
	17	Impact	Do the authors overclaim impact?
Sources: authors and sponsors	18	Credibility	Are the sources credible?
	19	Sponsor	Who paid for the experiments?
Recommendations	1	Adopt a typographic practice that is reader focused and works to integrate the processes of writing, designing, and testing.	
	2	Look more intentionally at differences across readers and across reading activities in typography studies — rather than focusing on detailed manipulations of layout.	

the reading act. More often than not this requires an approach that draws on multi-disciplinary expertise and knowledge so one can best understand the specific reader, the environment in which the reading act will take place, the content of the text, and what is the desired action or outcome. A text, inclusive of all its component parts, such as illustrations, captions, and headings, is written for a specific group of readers in a specific situation. Based on integrated knowledge of existing frameworks and empirical research results, a prototype is developed that shows what the result might look like. Best practice suggests that diagnostic and user tests* are conducted to confirm or disprove assumptions that were made during writing and designing. Based on performance results and preference data collected during conversations with readers, the prototype is modified and can be tested again.

This means that the participants, test materials, measurements/criteria, and contexts are completely integrated into a larger project. This approach allows for different models of reading, genres, languages, and characteristics of different readers. In usability tests, or reader-interviews, or participatory design, they all provide reactions and feedback about both the contents as well as the typographic design of specific information in a specific context. An approach such as this allows typographers to tailor texts to specific kinds of readers using specific kinds of texts, but it should not be assumed that these results can be extrapolated to texts or readers more broadly. This approach is ideal when the need and opportunity to create bespoke documents is present.

Second, it may be more productive for typography studies to look more intentionally at differences across readers and across reading activities rather than focusing on detailed manipulations of layout. Reading contexts differ dramatically as well as the intent of the reader and the reasons they engage with texts at all. Consider the commotion and high stakes of a hospital emergency room and the importance of administering the right medicine at the right dose. What if that reader was tired or distracted during any of this action? How might that impact reading? What if they are dyslexic?

The consequences of these two recommendations are likely to affect four areas: typography research, the design of materials for experiments, education, and practice.

Typography research that investigates hypotheses that are focused on material design rather than on the reader may be limited in capacity to further the progress of the field more generally. Typographic design is contextual, and every reading action is different, but typography must find a way to generalize from the knowledge generated

* Dyson (2017) provides a thorough examination of research methods relevant to design for reading and offers a discussion of how and when this range of methods may be useful, including historical accounts, applying frameworks, drawing on heuristics or expert opinion, diagnostic testing, user research, and empirical research experiments.

scientifically and from the rich history of craft knowledge to create reading objects and scenarios that are usable and useful. Typography is likely to find more value in examining how different readers interact with similar materials under similar reading conditions. This is likely to say more about design for functional readability. This suggests that typography research that is collaborative and multidisciplinary will be most productive for the field of knowledge today.

With this said, however, it is also important for typographic researchers to better communicate their value within a collaborative model and to be clearer about the importance of typography at problem framing and study design stages of research — it cannot be an afterthought. Discussions in this realm more readily understand the value of psychology to typography but the value of typography to psychology is less well understood. When designers are included in study framing and design, the question and hypothesis change. More considerations can be given to how the reading materials might be impacting reading processes and reader behaviors so to create a better understanding of readers as well as reading material.

One key concern in education is the limited exposure students in undergraduate and postgraduate design programs have to research methods informed by the social sciences. This leaves many practitioners with a limited knowledge of the contribution psychology has made to reading research as well as minimal knowledge in how those studies might be interpreted. This has resulted in a history of perpetuating ideas. This article aims to point to some of the issues caused by the limited exposure by providing questions that could help to start assessing an experimental study.

Lastly, it is important for practitioners to recognize that psychology is asking different questions than typography researchers and this dictates the data that is collected and how it can be applied. This does not mean that the data is not informative, but that it can only speak to a narrow set of variables that are often not practical for typographic application without interpretation and a compilation of the knowledge across the body of research and broader reading contexts. This implies that typographic practitioners need to be widely read and actively generating a knowledge of good typographic practice by stitching together the results into a cohesive story. This also requires active critical reflection of their own work and a thorough knowledge of experimental methodology so to test the knowledge generated in labs in actual reading environments. Just stating that “science is not forthcoming with a seamless web of rules” (Lupton, 2004) is an indicator that practice has unreal expectations of experimental research.

4. Conclusion

Of course, this is not the first article that claims to question the quality and validity of typographic research. Wheeler (1928), Spencer (1969), Lupton (2004), and Ole Lund's 1999 thesis clearly indicate the severe shortcomings of studies investigating the difference between the legibility of serif and sans-serif typefaces. Rob Waller's discussion about "single typographic variables" (1991) and Karen Schriver's hesitation (1997) should be used as pointers that the pre-1985 typographic research needs to be discarded.

The lack of application of the results of typographic research in practice is probably the most damaging critique. If the results were clear, helpful, and effective then they would be used immediately. We see this as a problem of the narrow focus of disciplinary approaches to research across both psychology and typography.

Since typography is typically concerned with the reading objects, research questions rarely examine individual reader differences. On the other hand, psychology is very concerned with individual reader differences but does not focus on an understanding about how the reading object and environment affects the reading act regardless of who the reader might be.

By listing the issues, we suggest four considerations that avoid the pitfalls of the readability/legibility research:

1. Typographic research must be interdisciplinary and collaborative;
2. Test materials must be based on best practice and have a high practical validity;
3. Design education must include a critical approach and scientific methods;
4. Researchers must focus on a clear user-action and establish the differences between people.

It is clear that there is never a single way of reading, and that a single typographic design of a text cannot suit all readers. We need to find out what kinds of reading people apply to different kinds of texts.

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Authors

Karel van der Waarde studied information design in the Netherlands (The Design Academy, Eindhoven) and in the UK (De Montfort University, Leicester, and the University of Reading). In 1995, he started a design–research consultancy in Belgium specializing in testing of information design. Most of the projects are related to information about medicines for patients, doctors and pharmacists. His research focuses on the effects of visual information. Karel van der Waarde frequently publishes and lectures about information design. Van der Waarde is a board member of International Institute for Information Design (IIID, Vienna, Austria) and the International Plain Language Federation (IPLF), and editorial board member of *Information Design Journal, Journal of Visual Communication, The Journal of Visual Political Communication,* and *Visible Language.*

Dr. Myra Thiessen is a researcher in the Design Health Collab at Monash University and is the program coordinator of the Communication Design program in the Faculty of Art, Design, and Architecture. She has rounded expertise as a design practitioner, educator, and researcher with expertise in design for legibility, readability, and usability. Her work focuses on information translation and accessibility, developing communication systems that enable people, including those who may be marginalized due to cognitive differences, to share and use information in healthcare settings and other complex environments. Dr. Thiessen is especially interested in how motivation, context, and environment affect comprehension and decision making, and she specializes in evidence-based design drawing on empirical research methods to test both the preference for and performance of visual materials. As part of the Design Health Collab this interest is applied across a range of user experience design contexts.

INVITED ARTICLE

Visible Language Evolves

Sharon Helmer Poggenpohl

(sharonpoggenpohl[at]me.com)

Abstract: The editorial goals of three editors for *Visible Language* are discussed sequentially, showing the development of the journal over 58 years of continuous publication. Particular attention is paid to research in communication design, a goal of the current editor. Several suggestions regarding the interdisciplinary nature of the journal and its future are discussed.

Keywords: design research; editorial design; research publications

1. First Exposure

My first encounter with *Visible Language* came in a professional design context. I was working on the first ever third grade thesaurus. The editor and I got into an argument about typography. He wanted to use the conventions present in the adult thesaurus — all cap, bold, italic, small cap, etc. I argued typographic coding would either escape the third grader's attention or overwhelm them. After all they were early readers. I was for having specific locations in the entry, a signal that a synonym or antonym could be found there; it was a location map. This was in the late 1960s. This should have been subject to a user study with children of an appropriate age. But that was uncommon at the time. Our argument was going nowhere, then he flipped a copy of *Visible Language* onto his desk. He asked if I knew the journal, I did not. I became a subscriber.

Merald Wrolstad was the founder of this journal. He had a Ph.D. from the University of Wyoming and he wrote his dissertation on typography. He worked as a designer at the Cleveland Museum of Art, where he had occasion to travel to Europe for the museum.

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Visible Language Consortium:
University of Leeds (UK)
University of Cincinnati (USA)
North Carolina State University (USA)

During those trips, he met and became friends with many key type designers. I borrow from those who wrote upon his death in remembrance of Merald in 1987 in *Visible Language* (Banks et al., 1987). One writer observed that he led a double life — a skilled designer and a family man, while obsessed with all varieties of visible language. First named *The Journal of Typographic Research*, the journal then took on a more inclusive and poetic title *Visible Language*. The name change signaled the breadth of scholarship he wanted to support. Writing little himself, he supported authors with a generosity of spirit. He devoted the journal to others' scholarship. I consider him one of my mentors.

He started the journal on a shoestring and kept it going for 20 years. After his death, I contacted the journal's advisory board on which I served, to see if anyone was interested in picking up the journal. There was no interest. About this time, I was visiting Pennsylvania State University and saw in their library all of *Visible Language* to date, volumes 1 to 20 lined up on a periodical shelf. There was more to design than just professional execution. There was experimentation, research, function, and aesthetics to be explored. I applaud Merald's curiosity and determination to keep *Visible Language* alive. Extending the life of the journal he so ably began seemed a worthwhile goal; I acquired the journal. I only wish that he was available to coach me on the complexities of running and editing this publication.

2. First Transition

At that time, I was teaching part time at the Rhode Island School of Design (RISD) in their graduate graphic design department. I thought it would be interesting to give selected graduate students a chance to design an individual issue of *Visible Language.* Tom Ockerse, the department head, would oversee their design and consult with them about the context and content. Consistency of style within the issue itself was also important. Students were paid as this was not an insignificant design and execution. The only constraint was the journal's six by nine-inch format printed in black and white. I enjoyed seeing the variety of their ideas; it was also a practical learning experience.

In its early days (1987) as I became the editor, digital typography had come on the scene and articles and images followed suit. RISD was exploring the digital transition, so our collaboration was seamless. We were all Apple users. I did many special issues, but I was warned that subscriber interests might not appreciate all of them. I had taken on responsibility for the journal, but I had little experience as a publisher or editor. I found that having guest editors not only lightened my workload, but I learned many subtleties from them about the editor's role; it was a kind of publishing tutorial. A sampling of special issues illustrates the broad range of interests — all connected to *Visible Language* (Table 1).

Table 1. A sample list of twelve special issues gives a sense of the range of journal interests.

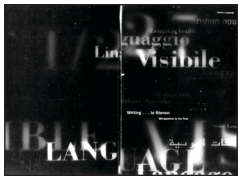
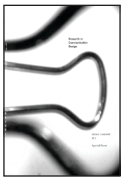
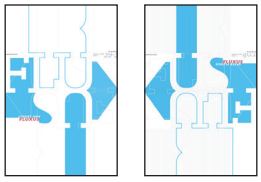
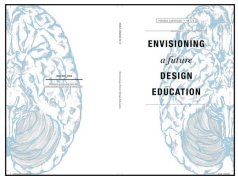
Cover(s)	Issue(s)	Topic
	26.4	Diagrams as Tools for World Making
	27.1 & 27.2	Writing in Stereo: Bilingualism in the Text
  	28.1, 28.2, & 28.3	New Perspectives: Critical Histories of Graphic Design
 	34.1 & 34.2	Words in Space
	36.2	An Annotated Design Research Bibliography: By and for the Design Community
	36.3	Research in Communication Design
	37.2 & 38.1	Cultural Dimensions of Communication Design

Table 1 (continued)

Cover(s)	Issue(s)	Topic
	39.3 & 40.1	Fluxus and Legacy
	41.3	Visual Metaphor in User Support
	43.2, 43.3, & 44.1	Communication Design Failures
	45.1 & 45.2	Punctuation
	46.1 & 46.2	Envisioning a Future Design Education

Special issues were largely based on guest editor interests and research. The leaning during my editorial tenure was to expand from the fairly strict Wrolstad attention to typography and reading to include communication design. I would call my editorship rather fuzzy in its search for a focus. Research had yet to emerge as a useful consideration for academics in design and even less so for practitioners. There were only two Ph.D. programs in a design department in the United States during the decades from the late 1980s and following. There were more doctoral programs in Europe. Doctoral students can identify questions in need of answers, and they have the time, interest, and methods with which to explore them. Research in communication design is coming of

age, nevertheless not everyone sees its relevance as they are often caught in the pursuit of style rather than function and substance.

Digital technology and the web created numerous changes. Everyone became a potential writer, photographer, translator, or designer. Quality of course was wobbly as many filled forms that rendered a design pattern, while some were copycats picking up current design trends. At the same time, access to information became overwhelming. Willingness to spend the time to read a deeply argued position paper, regardless of whether research, history, or opinion, evaporated. We wanted people to write succinctly and cut to the informational essence. Three decades ago, Brock Haussamen (1994) wrote "The Future of the English Sentence." In it he took an historical look at over four centuries of English writing and came to the conclusion that sentences were getting shorter and punctuation lighter. He speculated that this trend would continue. Older papers and books that I consider to be touchstones of thinking are often overlooked because of their age. Information is everywhere, but do we have the time and motivation to process it?

In 2008, I wrote an article titled "Design, Literacy, Discourse and Communities of Practice" (Poggenpohl, 2008). In it I listed 29 journals related to design and communication, their websites, focus and longevity. It is with some pride I note that *Visible Language* was the oldest of these journals, published continuously from 1967. From the year I wrote the article, the longevity of the journals cited could be estimated. Some of these journals faded away; often because they failed to find their community of practice and/or there was insufficient financial support primarily through subscription. Of the 29 journals listed, 13 survived, two merged with other journals on the list, 12 disappeared. One publisher maintained an archive of former publication. If no information was present on a website, I presume the title is no longer published, because journals must have a website. Nevertheless, new design journals appeared taking a particular focus in the attempt to capture a community of practice. One such journal was *She Ji: The Journal of Design, Economics, and Innovation.* Underwritten by Tongji University in Shanghai, it took optimism and determination to start a journal from scratch. I was able to build on the work of the founder and first editor. The journal was international from the start. But finding a community of practice was not so easy.

Visible Language was a big idea. It is so ever present in our lives that it tends of be invisible. From typography and a reading focus, I pushed the journal into communication design, a larger context. Now Mike Zender has extended it to be more research oriented; I applaud this.

Designers know little about research — how to do it or how it can enhance the project at hand. User-centered, also called human-centered research, began in the late 1990s as the need for study of relationships between technology and people was recognized.

Especially in the screen dominated environment in which we now live, how people navigated and processed their tasks became particularly in need of user research. How we access, identify, and move through information became an issue. The shift in processing information changed.

At that time, I was teaching graduate students at the Illinois Institute of Technology's Institute of Design in Chicago. Research became a focus and an internal Ph.D. program in design existed. Importantly, it was within a design program where design was on everyone's mind. Doctoral programs that lack such a grounding may teach research techniques and end with a dissertation, but they lack the rich ebb and flow of design argument. This is where researchers in design are created.

3. Next Transition

After serving as editor and publisher for 26 years, in 2013 I gave the editorship to Mike Zender at the University of Cincinnati. The university also acquired the journal. Within the context of communication design more broadly, Zender focused on research. Now was the time that design programs began to realize all design could not be done in an off-the-cuff manner. The journal from its original idea adapted and changed in a positive way. Under Mike's guidance, a consortium has been formed of three universities to share in developing and executing the ongoing evolution in *Visible Language*'s program. As mentioned, these are challenging times to run a publication.

I cannot resist making some suggestions about what this program of research might consist of. It would be interesting to survey the research methods already in use. Certainly, evidence-based methods like user-centered research or technically oriented eye tracking, or even historical analyses that call out and interpret evidence from multiple points of view, are useful. A question of interest is: What characterizes useful research results for practitioners and how do we bring this to their attention? Perhaps articles that demonstrate specifically how research is used, what research ideas are discarded as too big or undoable, might result in a kind of case study.

Interest in typographic studies remains ever present, and the generation of writing systems for those cultures without one is particularly interesting. Cultural preservation depends on the written record in large part; those without such a record will disappear. The history of the generation of writing systems and their typographic translation are worthy of scholarly attention. Likewise, the "reading" of pictograms, diagrams, and other non-typographic information also needs study beyond a quick understanding of message or appreciation of aesthetics.

Non-designers in large part misunderstand the range of what designers can contribute. Designers need to formally stake out the territories they already work in as synthe-

sizers, creator of prototypes, people who think not in abstractions, but in the world of people needing information. Questions can be formulated in early project work: What do I not know that is essential to the work? What research exists that answers my question? Who does such research? Why or how will research enhance the success of the project? Many practical considerations follow from this approach.

A coming challenge that is likely to intensify is working with others who come from different disciplines. This comes with larger and more critical projects; it comes with less frivolous goals. Designers have always worked with writers, editors, photographers. This has expanded to code writers, technology experts, and computer scientists. Now psychologists, sociologists, statisticians — the list could be very long — contribute to design communication. Design is moving from its art-centered core into more meaningful work that centers on healthcare for example — something we all care about. Jorge Frascara guest edited a "Design and Health" special issue (*Visible Language* 49.1 and 49.2). Understanding financial systems is another. We have a stake in bringing our skills in design and research to realms that are critical for people to understand.

4. Conclusion

Taking a look back, in 1971 Wrolstad created a chart outlining *Visible Language*'s concerns. He divided Conception & Formulation from Reception & Interpretation (Figure 1). The world of *Visible Language* has expanded and changed significantly since 1971. A new retconning of the journal's interests is in order. Building on the past, adding the present, and looking speculatively to the future would bring some clarity to the journal's program. The result might be a three-dimensional diagram or something that exists in time on a website. It probably is the result of much back and forth by a team of interdisciplinary people. It would be a worthy contribution to the journal and beyond. Instead of a Call for Papers, why not engage researchers and practitioners in the challenge to map the journal's concerns and publish the most interesting?

Returning to where this paper began with the argument about typographic coding or spatial coding, a simple user study giving children either option, while performing a related task, could have answered the question. The question could be expanded to include whether they remember the coding a few days later, whether a spatial diagram helps them, or the calling out typographic alternatives. Developing the question is a critical step. Children are great subjects for study, they like to be consulted and express their opinions. It was often surprising what research revealed when given an open-minded chance. Matching graduate students to research with children is a non-threatening experience — it overcomes graduate student reluctance to engage.

VISIBLE LANGUAGE

Conception & Formation ⟶ ⟵ *Reception & Interpretation*

VISIBLE LANGUAGE FORMS ON A SURFACE

Generation of symbols	*Application & Organization*	*Physical Response*	*Mental Response*
Relation to language generation	Language medium and language structure	Neurophysiological (e.g., vocalism in reading)	Meaning/ form dichotomy
Origin & evolution of the alphabet	Comparative writing systems (e.g., phonetic/ non-phonetic)	Reading/hearing relationships	*Meaning*— language organization and comprehension
Post-typographic electronic generation	Writing/speech relationships; phonetism of the alphabet	Alphabetic efficiency; eye movements; fatigue; search	*Form*— non-verbal communication of letterforms
Alphabetic prototypes	Typographic & electronic letterform display	Legibility & perception	Visible/oral language dichotomy; "primacy of speech"?
Script and type design—hand or machine	Environmental "signing"	Initial visual discrimination training	Visual encoding of verbal materials
Influence of tools	Paleography	Machine reading	Conscious & unconscious
Augmented alphabets (e.g., ita); shorthands; "universal" scripts	Descriptive bibliography		Literacy
Electronic representation of speech	Practice of the arts: calligraphy, concrete poetry, letterforms in plastic media (e.g., Paul Klee)		
Graphology	Comparative sight/sound media (e.g., musical notation)		

Figure 1. Reproduction of Wrolstad's (1971) chart of *Visible Language*'s concerns. [Editor's note: This reproduction utilizes Baskerville URW and retains many nuances of Wrolstad's original (e.g., line breaks, uncapped "symbols" in the first head) with imperfect adherence to others (e.g., single redrawn arrows from what was an arrow glyph with two em dashes of indeterminate origin). Baskerville URW was the closest approximation of the original Baskerville immediately available for typesetting.]

Now returning to Wrolstad's chart (Figure 1), the journal has a degree of responsibility for design's awakening in its ability to create and use research. Not all research is complex, some is fairly straightforward and simple. Can we collectively sort out the many technological changes, time limitations, and competition for attention that we encounter daily that complicates our lives? Is this a worthwhile task for the journal? Can we make functional and effective communication that not only looks good, but goes beyond the surface to the frontier of real understanding?

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Author

Sharon Helmer Poggenpohl taught in three remarkably different and notable design programs: the Institute of Design (ID) at the Illinois Institute of Technology in Chicago, the Graphic Design Program at the Rhode Island School of Design, and Hong Kong Polytechnic University's Design Program. Working with graduate students with Keiichi Sato, she coordinated ID's PhD program in design. She was a proponent of human-centered design as well as collaborative and interdisciplinary team work. A generalist, she is a critical voice regarding design education and its future. She received two teaching awards, the Education Award from the Society of Typographic Arts and the Master Teacher Award from the Graphic Design Education Association. For 26 years, she edited and published *Visible Language,* an international, interdisciplinary journal that covered visual communication research and experimentation. She encouraged research and publication to deepen scholarship in design. A recent book review was "A Book to Think With," covering Geoff Kaplan's *After the Bauhaus, Before the Internet,* based on the Yale conference of the same name (in *Visible Language* 57.2). "Waste and Agency in the Digital Era: Who's in Charge?" appeared in *She Ji: The Journal of Design, Economics, and Innovation, 6*(3). She self-published *Design Theory to Go, Connecting 24 Brief Theories to Practice.* With Keiichi Sato, she co-edited *Design Integrations; Research and Collaboration with Intellect.*

← continued from page iv

2011

imon was having a bad da
irst, he had a dream□[1]
bout some things he reall
lidn□[2]t like□[3] carrots,
vet□[4] sloppy kisses□[5] and
arly morning□[6]s. Then,
ıe heard his mum shoutin
□[7]Get up□[8] Simon□[9] Do
ou want a lift to Tom□[10]s

2008

Research Issues in Art Design and Media	1474 2365	*http://www.biad.uce.ac.uk/r riadm*
Scandinavian Journal of Design History	0906 3447	*http://www.designhistory.dk*
Visible Language* (formerly Journal of Typographic Research)	0022 2224	*http://trex.id.iit.edu/visiblel*
Working Papers in Art & Design	1466 4917	*http://www.herts.ac.uk*

Note:
** designates peer reviewed*
First ISSN is print, second ISSN is electronic version

WORDS IN

Visible language **is ubiquitous, taken for granted;**

n for granted; it is often processed automatically
ery characteristics stimulated the Words in Space
ıot on paper or computer screen), by changing scale
blic (signage) or intimately expressive (a record of
s offer to reveal the scope and influence of visible
applications.

rooted and more recent roles for visible language
nterpretation and navigation.

Visible language is ubi
often processed autor
seen. These very charac
in Space special issues

2000

Today, the average sentence length is in the low 20s, and flow of information from subject to verb to object or complement is quite direct.

Science, that product of skepticisr
born of cultural diversity, is mean
to deal in certainties, in data whic
anyone anywhere could verify.
And for the most part it has. Our
self-referential mathematics and
wiggly yardsticks got us to the
moon. I think science works the
way a tightrope walker works: by
not looking at its feet. As soon as i
looks at its feet, it realizes it is
operating in midair.

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1994

1990

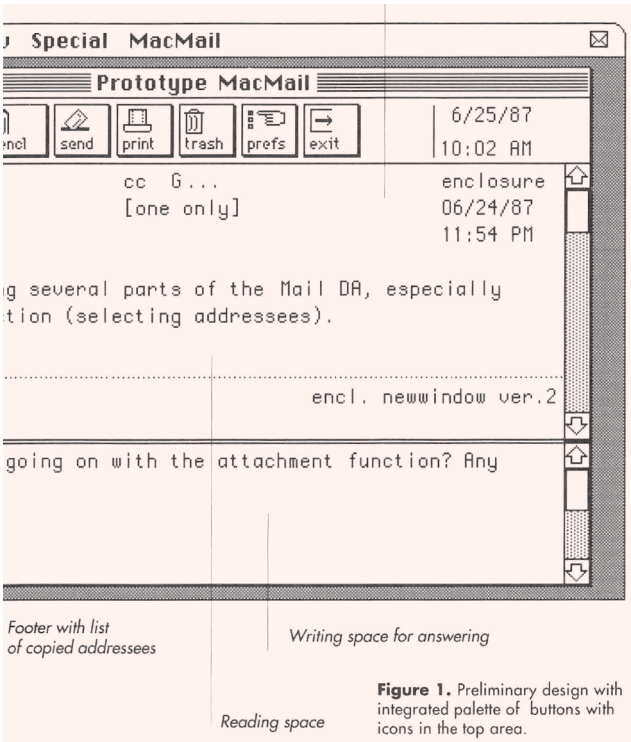


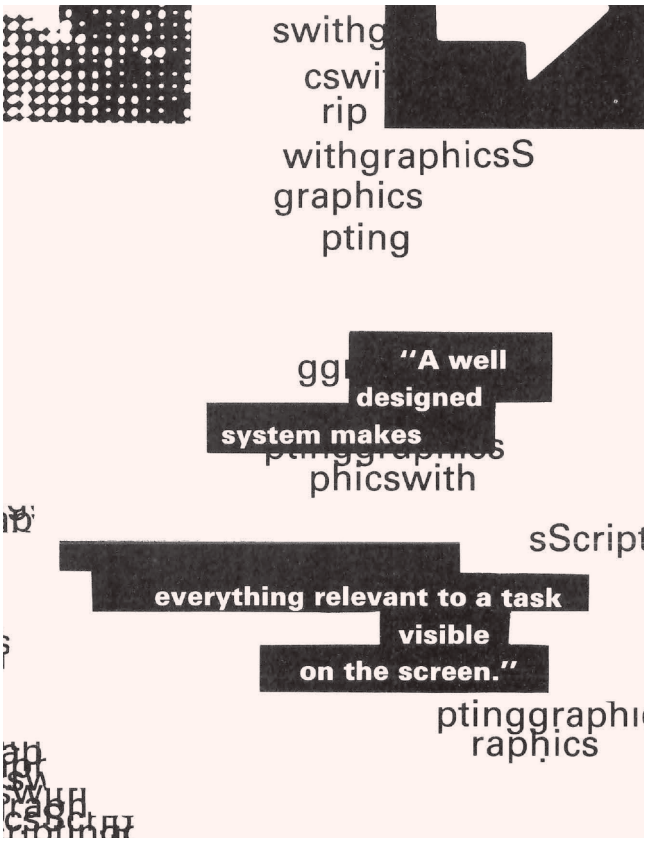
Figure 1. Preliminary design with integrated palette of buttons with icons in the top area.

1987

*Short of bringing Merald back to life, **Visible Langua** the case thanks to Sharon Poggenpohl, whom he spot He must have been right since here she is. This in itse tribute to Merald and his brain child and is sure to be typographic community.*

*Thanks to Merald and **Visible Language**, this commu to the extent that it has no real language barriers any academic, artistic, or any other. This was clearly ins **Visible Language** from the Journal of Typographic R as expressed in its format and Jack Stauffacher desig Research on the Visual Media of Language Expressio occasionally expressionistic gimmicks; and finally (Vo Research Journal concerned with all that is involved All this within the self same and scholarly format as a configuration.*

The occasionally provocative designs should not obsc was a new typographic i.e., visual experiment. So mu added up to an exhibition in Amsterdam as a tribute t to organize our investigation of every aspect of this vi expression."



1985

1982

1982

1979

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Volume XIII Number 4
ISSN 0022-2224

Special issue:
Graphic Design Education
Guest editor:
Sharon Helmer Poggenpohl

Experiment

Research

Theory

	A	E	F	H	I	L	T	K	M	N	V	W
CURVED												
STRAIGHT	+	+	+	+	+	+	+	+	+	+	+	+
HORIZONTAL	+	+	+	+		+	+					
VERTICAL		+	+	+	+	+	+	+	+	+		
NE DIAGONAL	+							+	+		+	+
SE DIAGONAL	+							+	+	+	+	+
CLOSED/OPEN												
INTER-SECTION	+	+	+	+			+	+				
CYCLIC		+							+			+
SYMMETRY	+	+		+	+		+	+	+		+	+
VERT. TERMINATES	+		+	+	+	+	+	+	+	+	+	+
HORIZ. TERMINATES		+	+			+	+					

Figure 4. Chart of distinctive features for letters of the alphabet (aft

The set of features is a little altered from Gibson's, though not mucl
Gibson's characterization of the letters even where I found it dubio
and "S"; and as mentioned above, I have redone "U" altogether:

1975

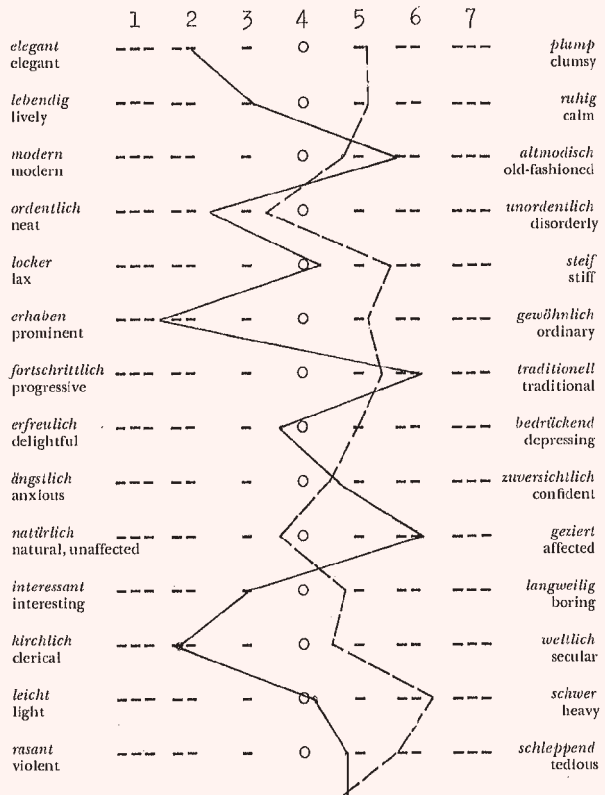
Why would a magazine with a great name like *The Journal of Typographic Research* decide to change it? For one thing, having to add a footnote every time the name is mentioned in order to explain its actual range of interests finally got to us. As a subscriber you will have to admit that no matter how broadly we attempt to define "typographic research," it no longer adequately describes the research efforts in the field or the major concerns of this Journal. "Typographic research" has become a label that has to be stretched; "visible language" is a concept that remains to be fulfilled.

At this stage we hesitate to allow ourselves getting backed into a strict definition of visible language. As the subtitle indicates, we are suggesting that it encompass the investigation of any expression of a language in visual form—writing, typography, signing, *et al.* Based on the four years of our publication, we will go as far as to attempt a general overview (overleaf), to indicate the range of our interests rather than to compile a comprehensive list of constituent parts. The chart suggests one way of looking at a simple interaction: on the left, a vast array of talent and ideas concerned with devising the visible language characters and arranging the configurations which end up displayed on a surface; on the right, our complex, interrelated physical and mental faculties which receive and process these visible language images. Obviously, there are important relationships that have not been expressed and categories that overlap or defy easy classification; your criticism is solicited (make a photo copy of the page and add your own comments). You might also take a look at the list of major articles which have appeared in the Journal (pages 93–96) as a further indication of the range of interests we are identifying as visible language research.

Given this provisional outline, the Journal's primary purpose might

5

1971



The objectives of the Journal of Typographic Research are quite simply stated: to report and to encourage scientific investigation of our alphabetic and related symbols. To attempt further refinement at this time would serve only as an invitation to a host of premature semantic and jurisdictional quibbles. Once underway, the Journal will tend to define its own role, both through editorial direction and as a result of the inevitable interaction with the various related scientific, academic, and artistic disciplines. A year from now would seem to be a much more appropriate time for assessing the Journal's continuing purpose.

Perhaps the one thing that makes this journal unique among scholarly publications—and, we feel, may prove its greatest strength—is the range and variety of interests with which it will, by definition, come into contact; e.g., pure communications theory, practical application of legibility results, artistic intuition of experimental typographic design.

We are, therefore, not going to enter the Science/Humanities/Art controversy over which has the more enlightened approach to Truth! There are no sharp breaks—no boundaries—where the realm of science ends and those of the humanities and art begin; and you will find representative examples of all three in these pages during the next year.

The anticipated audience for the Journal is as varied as its subject matter. To those, proud of our typographic heritage and perhaps a bit fearful of the influence of research on "the *art* preservative," we hasten to offer reassurance: first, of the Journal's loyalty to the older traditions of typography and, second, of our conviction (paraphrasing Santayana) that truth is, indeed, often more easily and adequately conveyed by art than by analysis—which is no reason for forbidding analysis, but *is* a reason for not banishing art.

There will undoubtedly be some readers who, with increasing dismay, see the Journal only as a collection of fragments, crying for integration and synthesis. For a scholarly journal, pertinent new findings must be

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Call for Papers: Special Student Issue 2025

Word|Image|Space|Materiality|Experience

Visible Language is looking for submissions for an issue to include student articles on research into digital, graphic, and typographic design. In particular, we welcome submissions using methods that can be broadly categorized as either collections-based approaches or participant studies. The objective of the special issue is to allow students to experience the publication process. The research might be on a smaller scale than would normally be published. Accordingly, studies may involve smaller numbers of artifacts or participants, as appropriate to an exploratory study. The research would need to meet the criteria for a rigorous study including:

- A clearly stated research question
- Well-articulated scholarly foundations
- Appropriate research design or framework for analysis
- Valid interpretation of findings
- Relevance to design practitioners and future practice
- Ethical approval for the study and/or copyright permissions to reproduce relevant images, as relevant to the research

Visual essays are welcome — provided a robust, scholarly, and reflective approach is demonstrated and the copyright permissions are in place.

In line with the aims of the journal, we wish to actively support emerging scholars and therefore encourage supervisors/tutors to be involved in the publication process with joint authorship where appropriate. Following the practices of the journal, we are willing to liaise with authors to advise on what is suitable for submission, make suggestions, and provide feedback. Please contact Associate Editor Jeanne-Louise Moys (j.l.moys[at]leeds.ac.uk) or Editorial Manager Matthew Baxter (m.g.baxter[at]leeds.ac.uk) well in advance of the submission deadline with any questions about the submission criteria or process and for advice.

Submission requirements. A student for the purpose of this special issue is someone who, at the time of submission, is enrolled in an undergraduate or graduate program or who has graduated within the last five years. If graduated, the study being reported must have been done while a student.

More information is provided on the following page.

Criteria for acceptance

Criteria for acceptance to the special issue are:

- The submission was received on or before the date specified in the call for papers — September 3, 2025
- The submission must fall within the scope of the call for papers
- The submission must not be under review or have been published elsewhere
- The contextual foundations, limited to 1,500–1,800 words, must be scholarly, relevant to the objectives of the study, and cite the most relevant literature
- Polished academic writing
- While the special student issue editors will be looking for quality work, the standard against which the papers will be judged may not be the same as manuscripts by more experienced researchers
- Any revisions requested are carried out to a level accepted by the editors and within the specified timescale

For participant studies:

- The method(s) used to collect any data included must meet standards for ethical research, validity, and reliability
- Any statistical procedures used and interpretation of results must be appropriate
- The conclusions drawn from the results of the study must follow from the method and any statistics used

Submission length and structure

The submission should be no longer than 7,000 words for a research paper and 4,000 words for a visual essay.

For research papers, structure should include (as appropriate):

- Abstract
- Introduction
- Contextual foundations (including literature review, rationale, and objectives)
- Method (including examples of visual material, as appropriate)
- Findings
- Discussion (including interpretation of results and Implications)
- References in APA format

If you are submitting a visual essay, please contact Associate Editor Jeanne-Louise Moys for further discussion about the appropriate structure: j.l.moys[at]leeds.ac.uk

Submission and review schedule

The closing submission deadline is September 3, 2025 with projected publication in *Visible Language* 59.3 (December 2025) issue. Submissions will be blind-reviewed by two experts with feedback provided by September 25, 2025. Any revisions to the manuscript will be required by October 9, 2025. Final acceptance will be notified by October 31, 2025. The acceptance of a submission will be determined by Editor-in-Chief Maria Lonsdale and Associate Editor Jeanne-Louise Moys.

How to submit a manuscript. Manuscripts should follow the submission guidelines of *Visible Language* and they should be submitted online by **September 3, 2025.**

Dr. Jeanne-Louise Moys (j.l.moys[at]leeds.ac.uk)

University of Leeds, UK

Associate editor of *Visible Language*

inside

back

cover

Table 1. Nineteen questions for evaluating typographic research, with two recommendations.

Participants	1	Reading processes	Does the study describe the readers, conditions, and models?
	2	The starting point	What do we know about the participants?
	3	End points and aims	Is there a clear purpose for the person who reads?
	4	Different people	Are the participants university students?
Test materials	5	Test materials	Are the test materials described? Is there an accurate visual representation?
	6	Design of materials	If the test materials are shown, are they appropriate for the research question?
	7	Boundaries	Are the recommendations generalized without any boundaries?
	8	Language characteristics	Is the language, alphabet, and/or writing system defined and its unique characteristics described?
	9	External validity	Does the study deal with realistic looking texts and/or realistic reading scenarios?
	10	Variables	Is the combination of typographic factors described?
	11	Dated studies	Does the study rely inappropriately or heavily on old or outdated science?
Measurements and criteria	12	Measurement units	Is the type size specified in points?
	13	Appreciation	Is aesthetic preference considered?
	14	Reading measure	Is "the speed of reading" really an appropriate measure?
The experiments	15	Context	Is the experiment related to reading in real life situations?
	16	Global standard	Does the experiment aim for a gold standard?
	17	Quality of study	Is the study of sufficient quality?
Sources: authors and sponsors	18	Credibility	Are the sources credible?
	19	Sponsor	Who paid for the experiments?
Recommendations	1	Adopt a typographic practice that is reader focused and works to integrate the processes of writing, designing, and testing.	
	2	Look more intentionally at differences across readers and across reading activities in typography studies — rather than focusing on detailed manipulations of layout.	

8½×11″

6×9″