



WHITE PAPER OVERVIEW

The Infrastructure for *Sign Language* Translation

Why signed access has stayed out of reach at scale, and the platform, people, and standards that are changing the economics of producing it.

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Executive Summary

For deaf ¹ people worldwide, **full access** to information means **access in sign language**, their primary language. Captions and accessible documents serve a purpose, but for a person whose primary language is a signed language, those formats function as second-language accommodations rather than primary-language access.

Delivering sign language translation at scale has been impractical for nearly every organization that has sought it. The barrier has not been a shortage of skilled translators but the production process surrounding the translation: file management, studio time, lighting, scheduling, editing, rendering, and delivery. Each step has been performed manually, and together they account for most of the cost. The result has been a per-minute cost high enough to place any substantial volume out of reach.

That constraint is now easing, because the production process is moving into software. The automation of the labor-intensive steps surrounding the translation is comparable to the introduction of the printing press, which lowered the cost of producing text and, over time, widened access to written knowledge beyond those who could afford hand-copied books. Sign language translation is approaching a similar transition. The translation work itself is long established; what is new is the emerging technologies to produce and distribute it at scale. A translator can record from a simplified workspace while the platform performs background removal, timeline alignment, rendering, and delivery as a single pipeline. The translation remains human work; the production process around it does not.

For the first time, organizations of any size can plan and budget to make sign language accessibility an affordable, ongoing program. Language service providers that hold the client relationships and employ qualified translators, but lack production infrastructure, can now quote and deliver such work. Accessibility teams can treat signed content as a defined deliverable rather than an indefinite goal, and public entities facing ADA Title II deadlines can plan against specific requirements rather than aspirations.

Alongside the platform, the team behind Sign Language Studio (SL Studio) commissioned and published a set of Sign Language Translation Standards, giving teams a shared definition of translation quality to work toward.

Regulation establishes a minimum. This paper concerns the infrastructure required to move beyond that minimum, toward access in a viewer's own language. The sections that follow examine how that infrastructure is developing: the relationship between human rights and the law, the production constraints that have limited sign language translation and the changes now easing them, the appropriate role of AI, the platform that manages the production process, and the standards that define quality.

The Floor and the Ceiling

Communication and access to information are widely recognized as fundamental human rights, and current regulation is one expression of that recognition. A consistent pattern appears across jurisdictions: the U.S. ADA Title II rule, the European Accessibility Act, the Accessible Canada Act, and the UK’s accessibility regulations each establish a compliance floor for digital content.² These laws recognize existing rights rather than create new ones; like much legislation, they formalize entitlements that people already hold.³

That floor is the legal minimum. A higher standard lies beyond it: full access in a person’s primary language. This section examines the gap between the two.



In the United States, Title II is the most immediate requirement. Its web rule sets compliance dates in April 2027 and April 2028 and applies to tens of thousands of public entities.⁴ The binding technical standard it adopts, WCAG 2.1 Level AA, extends well beyond video to include captions and audio description, text alternatives, semantic structure, keyboard operability, and document accessibility for PDFs, presentations, web pages, and training materials. It does not, however, require sign language for either video or written content. The signed-video provision sits at the higher AAA level, and no comparable provision exists for documents at any level.⁵

Content delivered in a signed language does fall under Title II, but through a separate and older provision: the effective-communication standard, which requires public entities to provide qualified interpreters and

other aids when needed for high-stakes individual interactions.⁶ That standard governs specific encounters rather than the routine production of an organization's broader content.

The principle is not new. The UN Convention on the Rights of Persons with Disabilities, among the most widely ratified human-rights treaties, opens its definitions by stating that "language includes spoken and signed languages."⁷ Signed languages are full natural languages, with their own grammar and spatial structure, and they do not map directly onto the written form of any spoken language.⁸

Most of a covered entity's content is written: documents, forms, web pages, training materials, and contracts. Captioning a video also renders it as written text, which likewise satisfies accessibility requirements. In each case the content meets the legal standard because it can be read. For a person whose primary language is a signed language, however, reading written material means working in a second language, comparable to an employee whose primary language is English, in a workplace where all material is written in Spanish. Median reading comprehension for deaf students leaving U.S. secondary schools has long been measured at approximately a fourth-grade level,⁹ and research indicates that sign language proficiency is positively associated with reading comprehension. The barrier is one of access rather than a limitation of the reader.

Meeting the floor satisfies the law, but it does not, in itself, provide content in the primary language of a reader who uses sign language.

Most public entities will stop at the floor, and not for lack of intent. Captions and document accessibility can be produced at scale at predictable cost. Sign language translation currently cannot: each unit is still produced by hand, without a shared industry workflow. A subset of high-stakes content will be signed by some organizations, while most content will remain at the floor.

The rule poses a bottom-line challenge for language service providers that functional infrastructure can resolve. For public accessibility leads, the task is meeting legal minimums and deciding which content to elevate to AAA standards, balancing compliance and quality.

The floor is not solely a public-sector concern. Other regulations, including the European Accessibility Act, apply to private companies, and independent of any law, any organization with deaf employees, customers, patients, or students has reason to exceed the minimum. The regulatory deadline gives public entities a fixed date, but the underlying need is general. The following section examines why the floor has been difficult to clear and what is now changing.

What Ends the *Scribal Era*



Exceeding the floor at scale is fundamentally a production problem, and it has a historical precedent.

Before the printing press, each book was copied by hand, one word at a time. The limiting factor was not the skill of the scribes but the physical capacity to produce copies. A single volume could take months, so texts remained concentrated among the few who possessed copies. The expansion of literacy that followed the press was not primarily a change in the demand for reading but a change in the cost of reproduction: the press separated the availability of knowledge from the speed of the copying hand.¹⁰

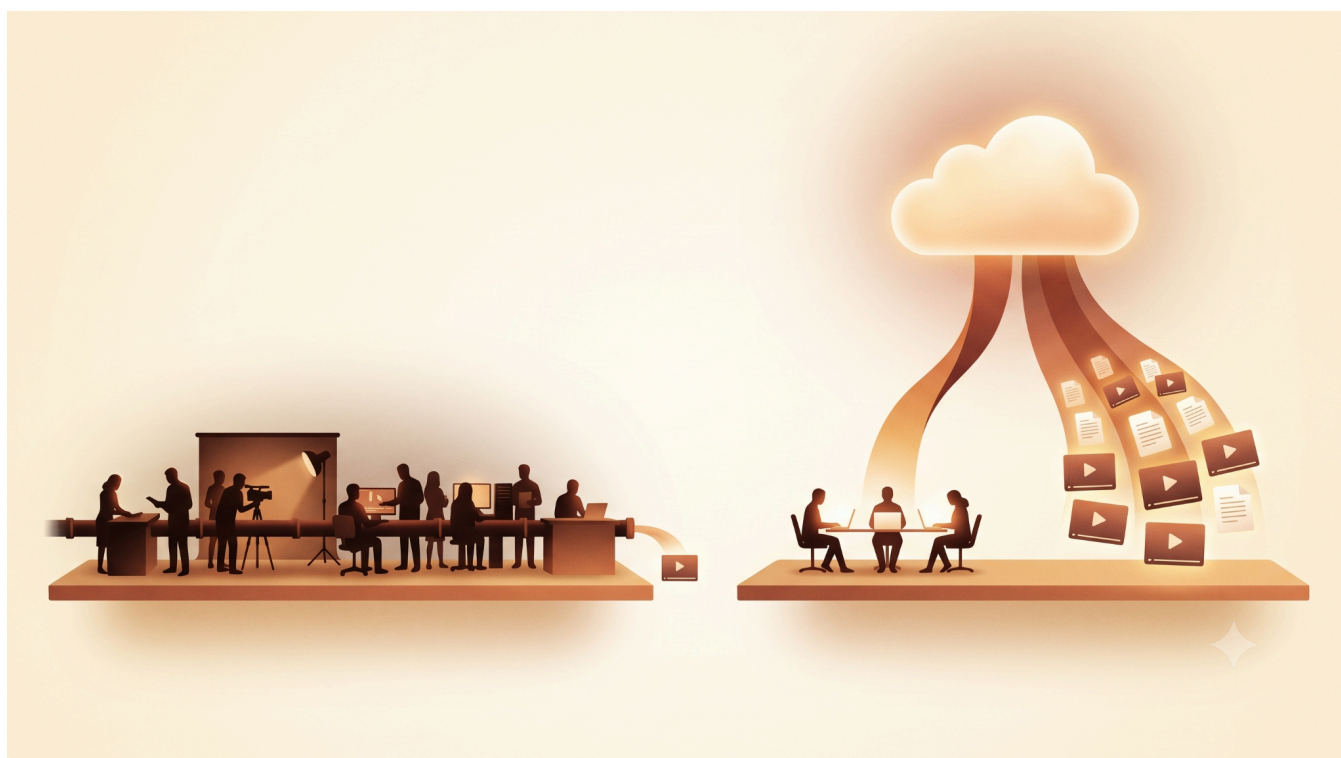
Sign language translation has remained in an analogous pre-print condition, referred to here as the *Scribal Era*. The constraint has never been the translators, who are highly skilled linguists performing rigorous work, but the absence of infrastructure capable of scaling that work.

Producing a single finished minute still requires hours of work surrounding the translation itself, regardless of the source material. This aggregate overhead is referred to here as the *Studio Tax*. Its visible component is equipment: the studio, lighting, camera, green screen, and editing workstation. Its larger component is the surrounding workflow, meaning the staff time required to move a project from intake to delivery, most

of which is spent on tasks other than translation. This workflow routinely costs more than the translation work itself.

Scale here represents the ongoing capacity for continuous translation—rendering into every required delivery format across a dynamic, growing library of content—rather than a single massive project. In practice, this increases the completed minutes generated by each translator.

With this infrastructure, a translator records in an ordinary room, without a green screen or specialized lighting, and the platform performs the remaining steps: background removal, framing, rendering, timeline synchronization, and delivery. Work that once required a physical studio now operates in software.



Once translation and production are separated in this way, the principal bottleneck is removed. Output is no longer limited by production hours, and cost tracks the translation work rather than the studio infrastructure around it. Total output across the field can increase substantially.

The categories of content affected are familiar: workplace and HR materials, healthcare and public-service content, educational materials, and customer-facing and public information, among others. As production cost declines, such content becomes feasible for organizations to make accessible.

Historically, access to many of these materials has depended on engaging a qualified interpreter each time. This approach can be resource-intensive and difficult to scale. By contrast, translating content once and

making it available on demand can significantly reduce ongoing costs while enabling skilled interpreters to focus on situations that require live, interactive communication. This is particularly valuable given the continuing demand for qualified sign language interpreters across many regions and service domains.

There is a commercial argument alongside the ethical one. In the United States, deaf workers are employed at a rate of approximately 58 percent, more than 15 points below the rate for hearing adults, and much of that gap reflects access rather than ability.¹¹ When the information a role depends on, such as onboarding, training, policies, and routine communication, is available in a deaf employee's primary language, that employee can learn the role, perform it, and advance on equal terms. Employees who are not required to work around inaccessible systems tend to be more productive and more likely to remain. Retaining a productive employee also avoids the cost of replacement, which is estimated at between half and twice annual salary.¹² As the cost of signed translation falls, the question shifts from whether an organization can afford access to whether it can afford to forgo it. The following section addresses where AI belongs in this work and where it does not.

AI's Role in Translation



AI has a role in sign language translation; the relevant question is where that role belongs. The answer depends on two criteria: quality and quantity. A high-quality signed translation is accurate, clear, natural, and culturally appropriate: it conveys the source meaning, is comprehensible without strain, and is signed as a fluent user would sign it. Fluency in signed languages depends on facial expression, head position, and body movement, which carry grammatical information rather than emotional coloring alone. Delivering that quality at scale is the central challenge, and the field's responses fall into two approaches, distinguished by the position of the human translator.

Future, AI-first translation (human-assisted): the AI generates the signing, and human translators assist at the margins. The most visible work uses 3D signing avatars for prerecorded output, and several large technology labs have released research previews representing the current public frontier. Its strengths are availability and scale, and it is well suited to short, predictable, lower-stakes content such as transit announcements, wayfinding, and service-desk information. Its limitation is depth: register, discourse-level fluency, and cultural interpretation are not yet reliable at production quality.

Progress in this area is real and rapid, but it is not yet sufficient, and the gaps in register and cultural interpretation are the same ones that recorded translation must address. The World Federation of the Deaf and the World Association of Sign Language Interpreters have cautioned against using signing avatars as replacements for human signers where full linguistic and cultural interpretation is required.¹³ The technology is useful within its appropriate scope but is not yet suitable for high-stakes content.

Today, human-first translation (AI-assisted): a human translator performs the translation, and AI handles the surrounding production process. Depth is preserved, because register, fluency, cultural interpretation, and non-manual grammar remain with the human translator. Comparatively few organizations are building in this direction. Some agencies do deliver handcrafted signed translations of varying quality, but they continue to operate at Scribal Era speed and cost.

While some platforms automate only individual stages, SL Studio moves the entire production process into software, end to end. This infrastructure is not a hedge against AI-first translation; it is a precondition for it. The structured workflows, quality standards, and growing corpus of production-grade signed content that human-first

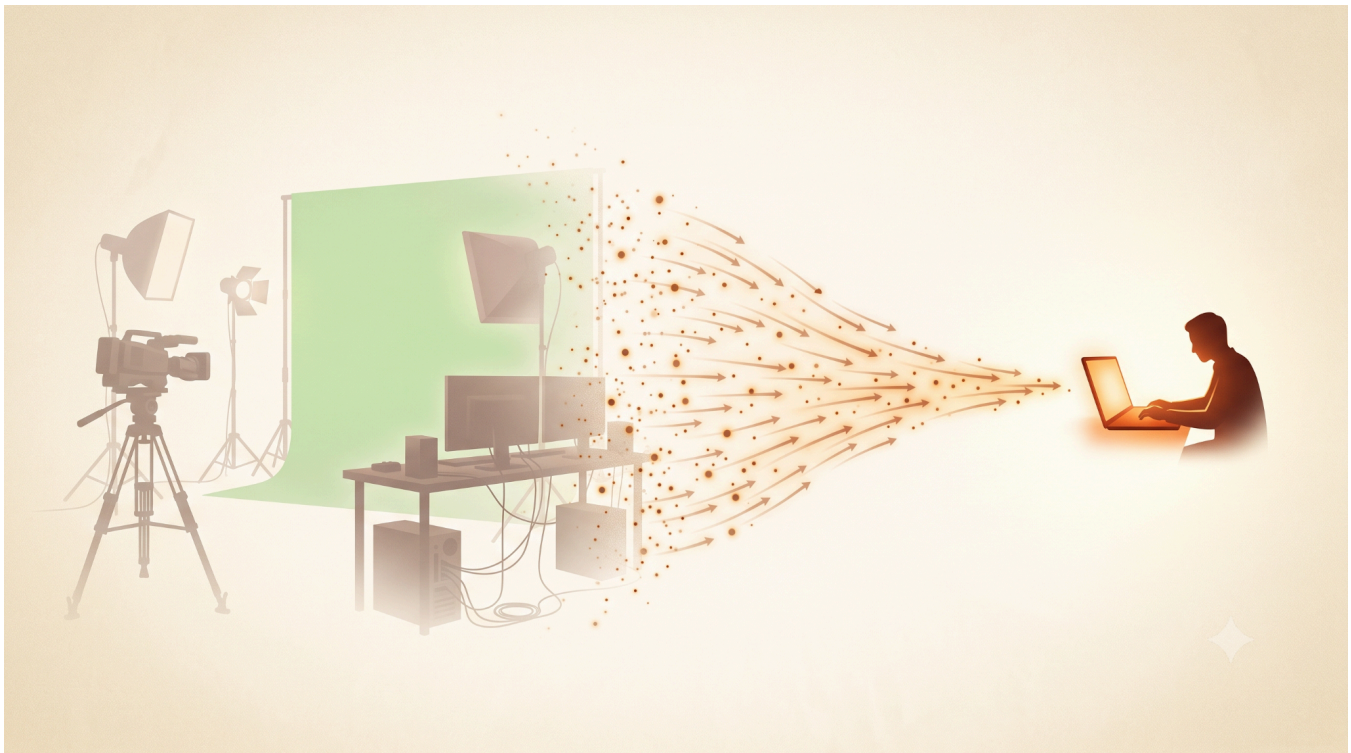


translation generates are the rails that future AI systems will run on. As generation technologies mature, they will integrate with this pipeline rather than replace it. Although human-trained translations require more time than synthetic outputs and are not meant to replace live interpreting, this approach remains a distinct advantage. For high-stakes, reusable signed content, AI-assisted human translation delivers the necessary quality today, scaling through translator-centered infrastructure toward primary-language access.

A translation is effective when it is accurate, clear, and natural, but reach depends on quantity as well as quality. A translation can meet every quality criterion and still reach very few viewers, and quality without reach has limited effect. Few current approaches deliver both. SL Studio is designed to do so, as the following section describes.

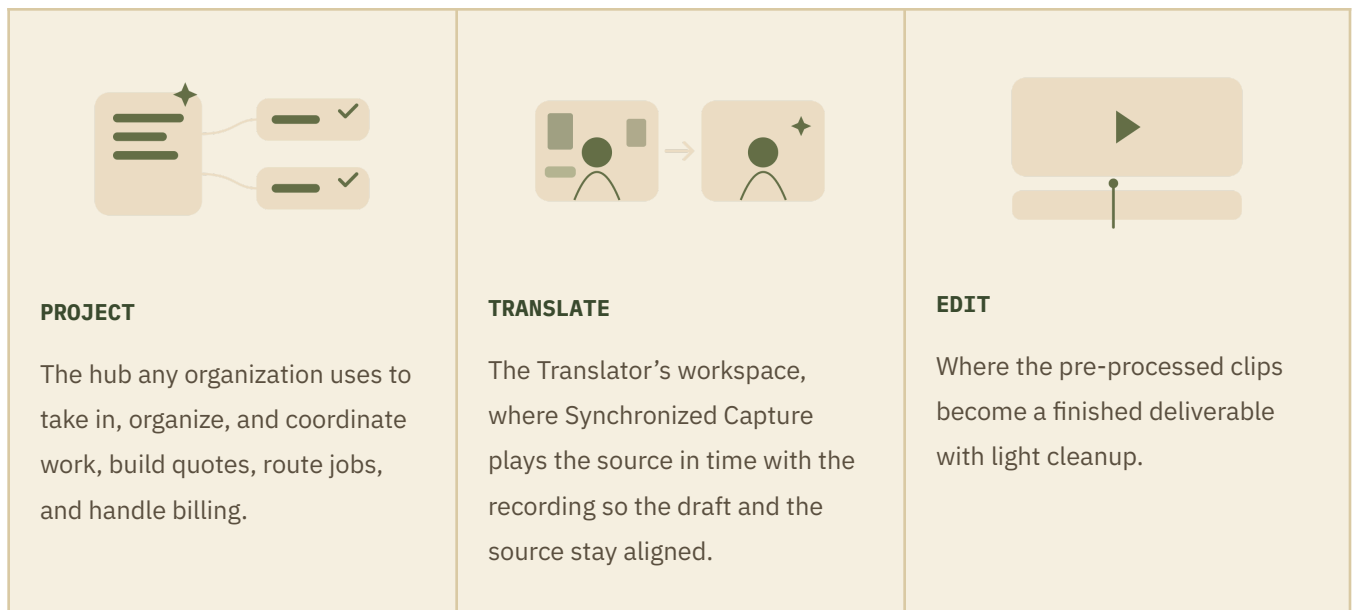
The Sign Language Studio

SL Studio is one implementation of the human-first architecture. It runs the production process in software rather than in a physical studio. In the Scribal Era workflow, a single signed-translation project passes through several people and multiple tools. High-stakes work often involves a two-pass recording process, a preliminary pass to settle vocabulary and a final pass in a studio, and even then the translation itself, the component that requires specialized skill, accounts for a minority of the total hours. The remaining technical steps constitute the production process surrounding that skilled work.



Within SL Studio, each stage of that process is automated. The physical studio is replaced by an ordinary workspace, with background removal applied automatically to every take. Specialized hardware is replaced by a laptop, so the work need not occur near a studio. Editing time is reduced from hours to minutes of review, because post-production runs automatically as takes are recorded. Manual coordination is consolidated into a single workflow from intake to delivery, and per-project quoting is replaced by automated pricing.

Three modules carry a job end to end.



While some organizations produce signed video by adding a signer to existing footage, a substantial portion of high-stakes content is not video but text. It exists in documents, which SL Studio handles directly by pairing the source document with a signed-translation player that follows it section by section. For a person whose primary language is a signed language, this is the functional equivalent of reading: moving through a document in one's own language and at one's own pace, as a hearing reader moves through written text.

This requirement shapes the structure of SL Studio: it is not a single feature but the underlying framework on which the work runs.



Background removal, synchronized capture, rendering, and delivery are the initial functions running on those rails, and the platform is designed to carry additional capabilities as the technology matures. One such capability is motion mapping, a digitally rendered layer applied over a human performance. It is currently in the design phase, intended as a method any developer in the field could adopt, and always paired with human translation rather than offered as a substitute.

Several boundaries define the platform's role. SL Studio is the rails, not what moves over them: it is not an AI that generates the signing, a live-interpreting interface, or a general-purpose video editor. It does not replace the translator; it removes the production work surrounding the translation.

What Comes Next

The infrastructure for sign language translation at scale is now being built, and the element that has constrained it is the one now moving into software: the production process surrounding each translator. Even with a finite workforce, once that process runs in software the output of each translator can increase substantially, allowing organizations to make considerably more content accessible.

For any organization responsible for signed access, the initial question is which parts of the content library, both video and written, most need to exist in a viewer's primary language, and which cause the greatest harm when they do not. These typically include healthcare, education, legal, hiring and onboarding, and public-service communication, among others.

The nature of the work depends on one's position. For a language service provider, it means establishing signed translation as a defined service line, with forecastable economics and a roster able to engage qualified translators regardless of location. For a translator, it means focusing on the translation itself, without the production cost that previously consumed most of a project's hours.

Until recently, a signed-translation program was difficult to budget, staff, and hold to any consistent standard. That is now changing, and organizations that establish effective practices early tend to become the reference point against which others are measured.

The benefits are specific. When a textbook, worksheet, or standardized test is available in a student's primary language, comprehension no longer depends on the student's proficiency in a second language, which changes outcome and what the student can achieve. The same applies to a patient reviewing a consent form and to an employee able to build a career commensurate with their ability rather than one limited by a language barrier.

The work is not complete. The architectures will continue to change, the training paths are still developing, and the standards will be revised as practical experience accumulates.

As the volume of signed content grows, a further question arises: what constitutes good signed translation, and who determines it. Mature fields answer such questions through shared conventions and the institutional trust that develops around them,¹⁴ and signed translation is only the beginning of that process.

It has had scattered guidance but no comprehensive professional standard covering a project from intake to delivery. The team behind SL Studio commissioned and published one, building on earlier work rather than replacing it.

The Sign Language Translation Standards set out seven core principles resting on four pillars of good translation. A working group of deaf and hearing practitioners, linguists, and educators developed the standard over more than a year. It covers the full workflow from intake to delivery and places a team at the center of the translation process: a lead translator, with an English reviewer, an ASL reviewer, and a subject-matter expert added when the source material requires one.

Workflows vary, and the standard accommodates that variation. A shared standard reduces wasted effort and keeps quality consistent without requiring every team to work in the same way.

Communication and access to information are fundamental human rights, and regulation establishes those rights as a legal minimum. For most of the field's history, that minimum was also the ceiling. It no longer is, and what organizations deliver is now a choice.



References

- 1 On the terminology used here: this paper uses lowercase "deaf" to refer inclusively to people whose primary language is a signed language, whether or not they identify with Deaf culture. Recent Deaf studies scholarship has questioned the capital-D/lowercase-d distinction as too rigid for an increasingly complex range of identities and language practices. See Annelies Kusters, Maartje De Meulder, and Dai O'Brien, eds., *Innovations in Deaf Studies: The Role of Deaf Scholars* (Oxford University Press, 2017).
- 2 European Union, Directive (EU) 2019/882 (European Accessibility Act), obligations in force since 28 June 2025 (technical anchor EN 301 549, incorporating WCAG 2.1 Level AA); Accessible Canada Act, S.C. 2019, c. 10, with phased digital obligations through December 2027 and December 2028 (CAN/ASC-EN 301 549); and the UK Public Sector Bodies (Websites and Mobile Applications) Accessibility Regulations 2018.
- 3 Such rights are commonly described as recognized rather than granted. The Universal Declaration of Human Rights opens with "recognition of the inherent dignity and of the equal and inalienable rights of all members of the human family," and a 1947 UNESCO survey conducted during its drafting found broad agreement on the rights themselves across very different cultures, even where their justifications differed.
- 4 U.S. Department of Justice, Civil Rights Division, Nondiscrimination on the Basis of Disability; Accessibility of Web Information and Services of State and Local Government Entities, final rule, 28 C.F.R. Part 35 (April 24, 2024); adopts WCAG 2.1 Level AA. Compliance dates April 26, 2027 (entities serving 50,000+) and April 26, 2028 (smaller entities), extended one year via Interim Final Rule effective April 20, 2026.
- 5 World Wide Web Consortium (W3C), Web Content Accessibility Guidelines (WCAG) 2.1 (W3C Recommendation 2018; current version 2023). Success Criterion 1.2.6 (Sign Language, Prerecorded) sits at Level AAA and asks for sign-language interpretation of prerecorded audio in synchronized media; there is no comparable sign-language criterion for documents at any level.
- 6 ADA Title II effective-communication standard, 28 C.F.R. 35.160: public entities must ensure communication with people with disabilities is as effective as with others, including auxiliary aids and services such as qualified interpreters.
- 7 United Nations Convention on the Rights of Persons with Disabilities (2006), Article 2 (Definitions): "'Language' includes spoken and signed languages and other forms of non-spoken languages."
- 8 On the linguistic status of signed languages, see Wendy Sandler and Diane Lillo-Martin, *Sign Language and Linguistic Universals* (Cambridge University Press, 2006); Scott Liddell, *Grammar, Gesture, and Meaning in American Sign Language* (Cambridge University Press, 2003); and Carol Padden and Tom Humphries, *Inside Deaf Culture* (Harvard University Press, 2005).
- 9 Traxler, C. B. (2000). "The Stanford Achievement Test, 9th Edition: National norming and performance standards for deaf and hard-of-hearing students." *Journal of Deaf Studies and Deaf Education*. Median reading comprehension for deaf students leaving U.S. secondary school has long been measured around a fourth-grade level; researchers continue to refine the figure.

- 10** Elizabeth L. Eisenstein, *The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early-Modern Europe* (Cambridge University Press, 1979).
- 11** National Deaf Center on Postsecondary Outcomes, "Deaf Employment Reaches Historic High as Workforce Gaps Persist," analysis of 2024 American Community Survey data.
nationaldeafcenter.org/news-items/deaf-employment-reaches-historic-high-as-workforce-gaps-persist
- 12** Society for Human Resource Management (SHRM), "The Myth of Replaceability: Preparing for the Loss of Key Employees." SHRM estimates the cost of replacing an employee at roughly 50 to 200 percent of annual salary, depending on role level. shrm.org/executive-network/insights/myth-replaceability-preparing-loss-key-employees
- 13** World Federation of the Deaf and World Association of Sign Language Interpreters, joint statement on signing avatars (wfdeaf.org/wfd-wasli-issue-statement-signing-avatars): signing avatars are not yet fit to replace human signers for content requiring a full linguistic and cultural read.
- 14** Adrian Johns, *The Nature of the Book: Print and Knowledge in the Making* (University of Chicago Press, 1998).