

APRIL 2024



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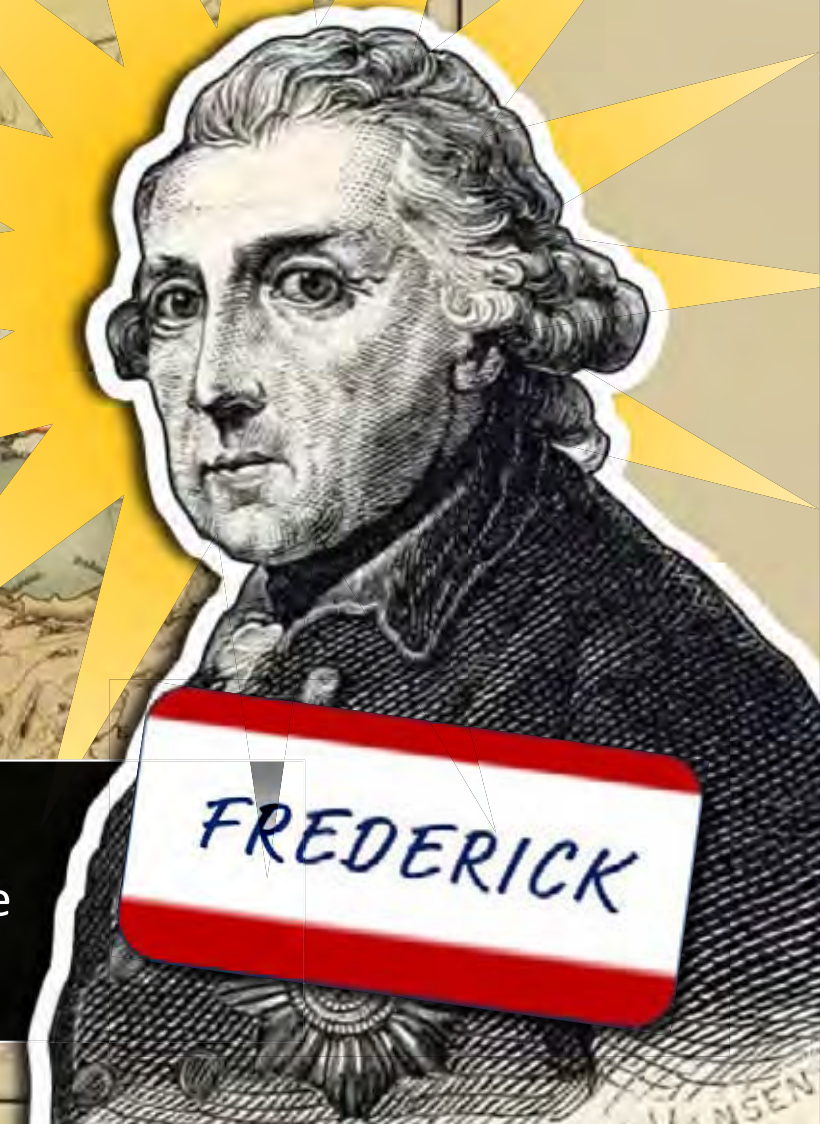


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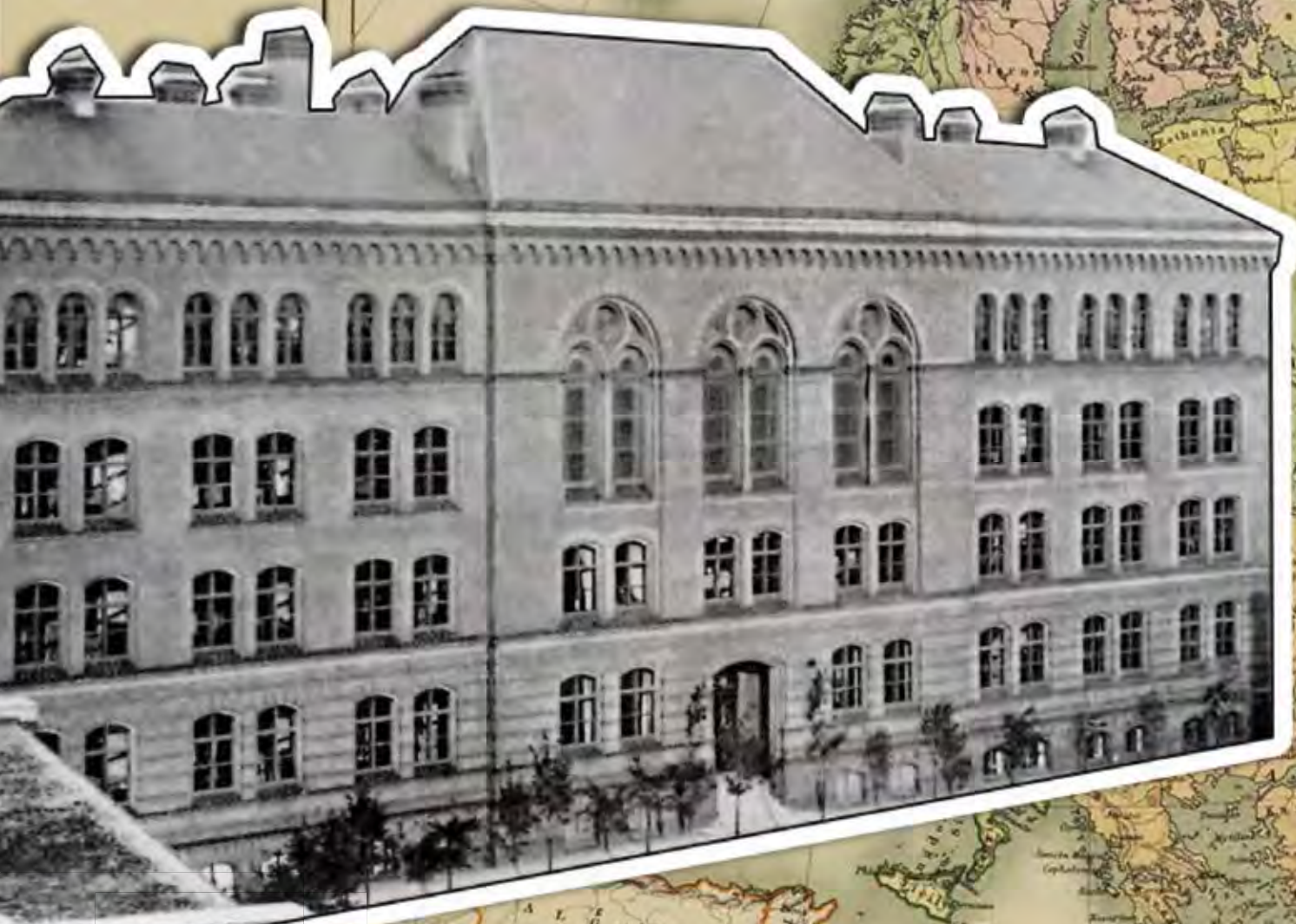
Much of what we envision as “formal education” can be traced back to the old Prussian schools of the 18th century.



Frederick the Great decreed that everyone, girls and boys from around 5 to 14 years old, had to be educated in these compulsory public schools.



18th CENTURY



The government subsidized primary, secondary, and normal schools. The system mandated specific training for teachers, national testing for all students, and a prescribed curriculum for each grade.

In 1810, Prussia introduced state certification requirements for teachers, and by 1812, there was also a final exam for students, called the *Abitur*. It was implemented in all Prussian secondary schools, and passing it was a prerequisite to entering the learned professions and higher echelons of the civil service.

18th
CENTURY



SCALE



STANDARDS



TESTING



CERTIFICATION

So, by the 1830s, we had a scalable education system, built on education and testing standards, including standardized curricula and standardized summative testing, and professional certifications.



Industrial Age Education and Testing

The Prussian system formed much of the foundations of our Industrial Age system of education and testing

1783



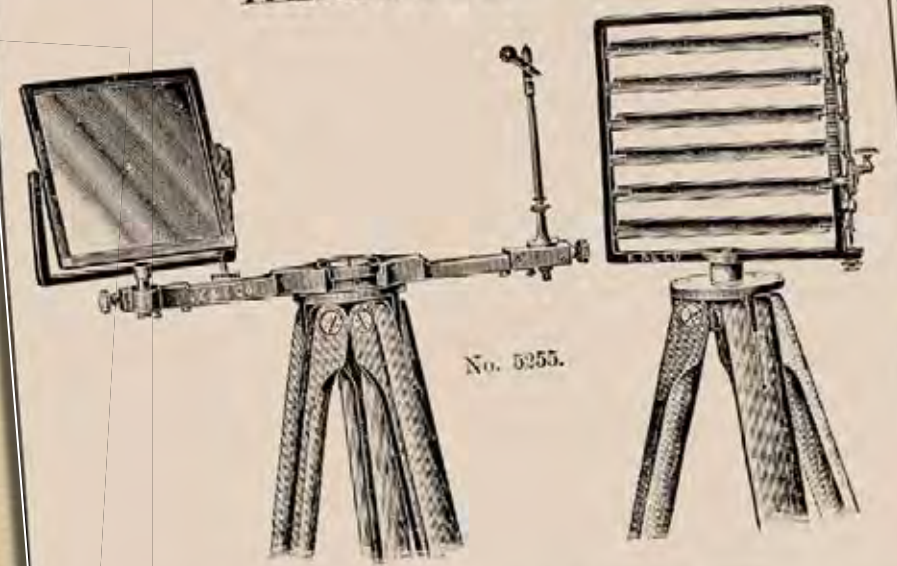
1817



The "Dandy Horse"

1822

HELIOGRAPHS



5255. Heliograph, as made by us for the U. S. Signal Corps: outfit complete for one station \$ 96 00

Consider some of the other inventions from around this time—the chronological peers to our Industrial Age education and testing system. The first steamboat in 1783, the first dandy horse (early precursor to the bicycle) in 1817, and the invention of Heliography, the first photographic process, in 1822.

For those with military experience, you're probably familiar with the famous book by Carl von Clausewitz, called *On War*. It was also a chronological peer to the invention of Industrial Age education and testing. Clausewitz was also engaged with the Prussian education system and spent over a decade as head of the Military Academy at Berlin.

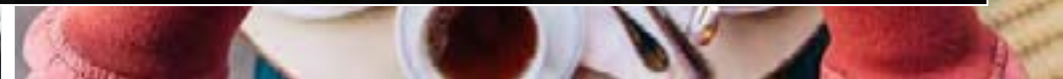
In *On War*, Clausewitz coins the phrase "Fog of War" to describe a leader's state of uncertainty due to a lack of information.

Fog of War





Consider how much the world has changed over the past 200 years. We've gone from steamboats to nuclear submarines and international shipping; from bicycles to spaceships; and Helographs to Instagram and VR.






Information Age



We're always connected, potentially always working and always learning. There's a constant rush of new technologies, changing conditions, changing global dynamics... We're in the Information Age—and beyond!





LIFELONG • 60-Year Curriculum



DIVERSE • Skills, XP, and Paths



COMPLEXITY • Interconnections

To remain competitive in the world, individuals need to engage in lifelong learning, a “60-Year Curriculum.” Individuals also require an increasingly diverse set of knowledge and skills (e.g., subject-matter expertise as well as digital and data literacy, cross-cultural competencies, empathy, and metacognition). And we need to navigate an increasingly complex, interconnected world.

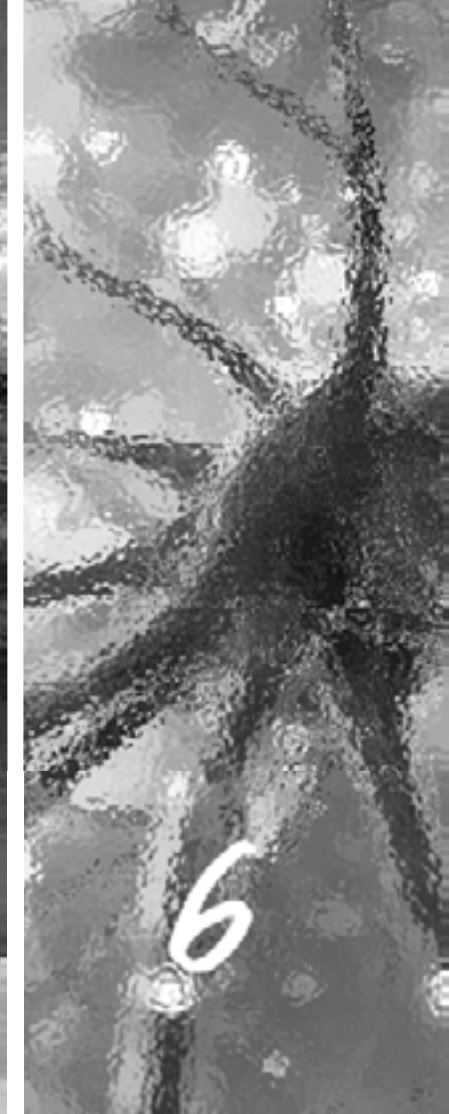
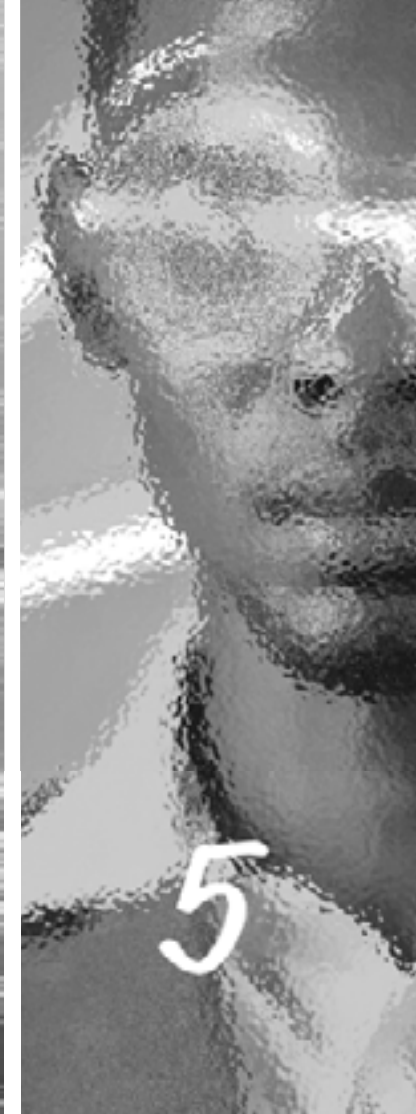
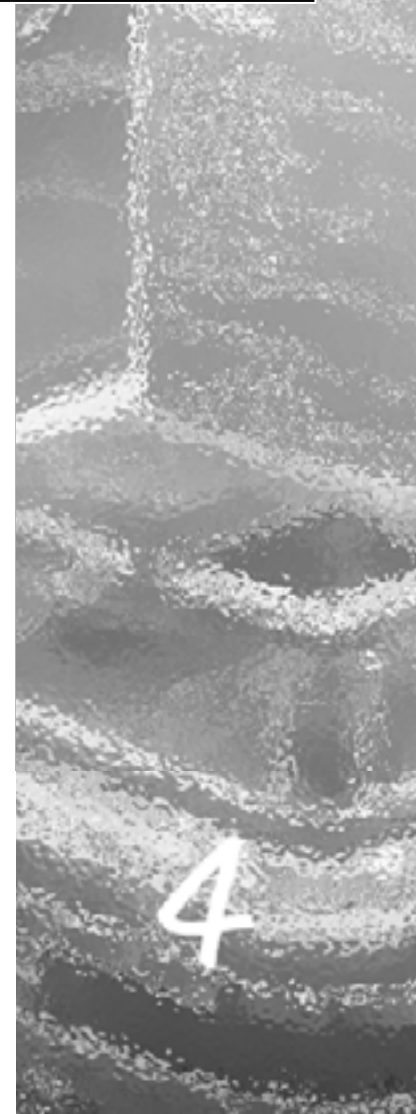
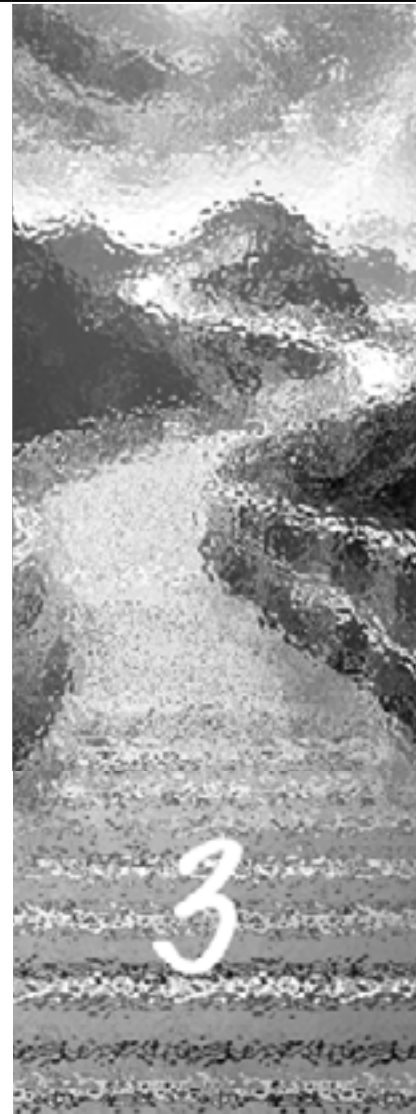
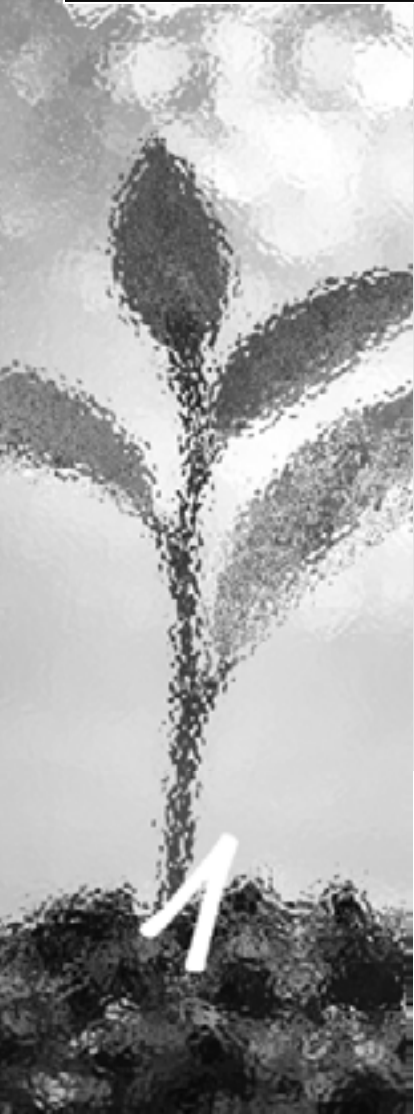
People are expected to do more, with rapid adaptability, and under incredibly complicated conditions.

...and today's "Fog of War" isn't a lack of information; it's a glut of it. We're overloaded and swimming in a sea of churning complexity.

**OVERLOAD • Disjoint, Incomplete,
Overwhelming Information**

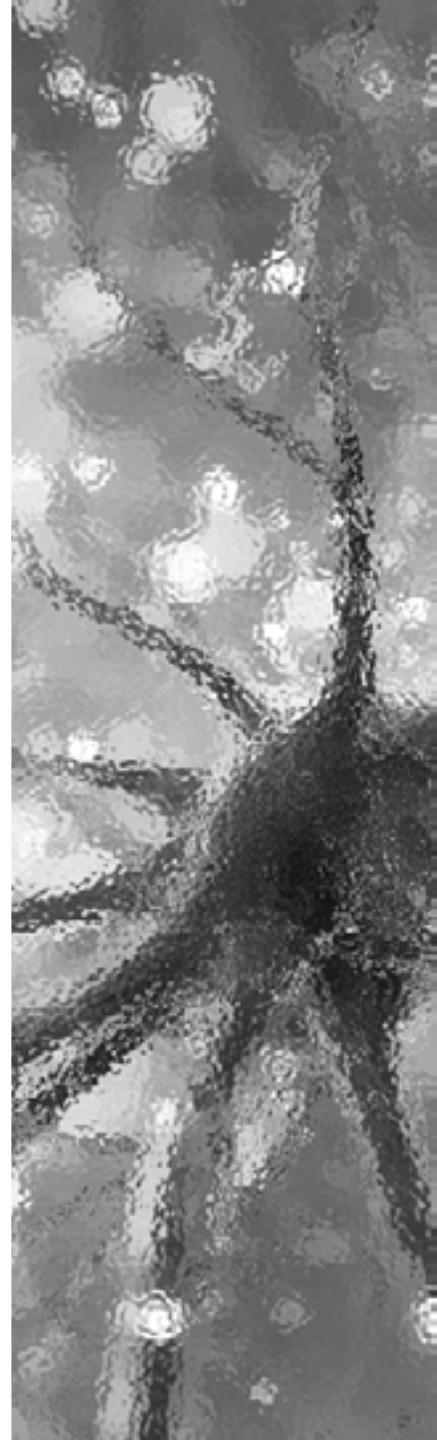
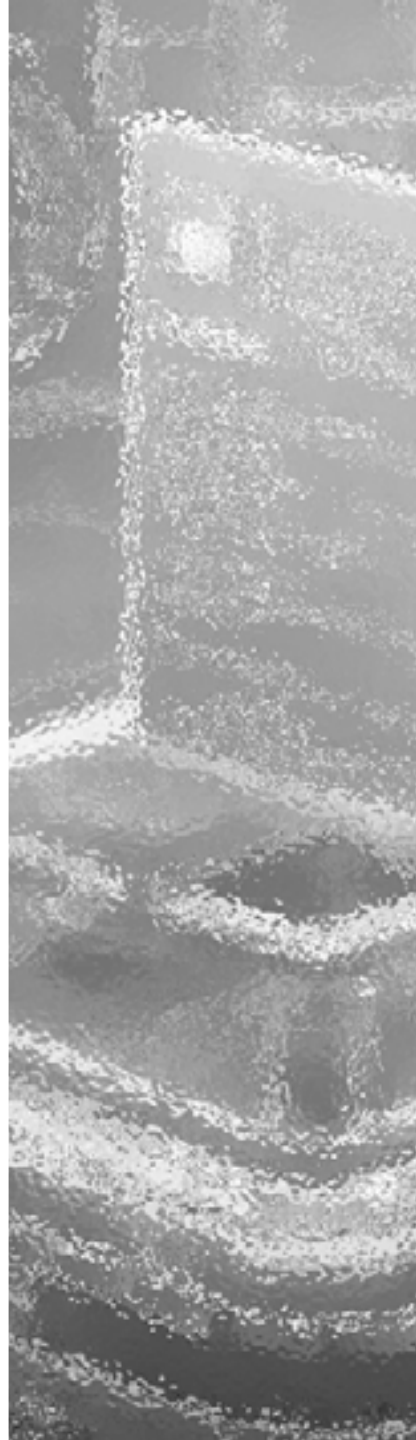
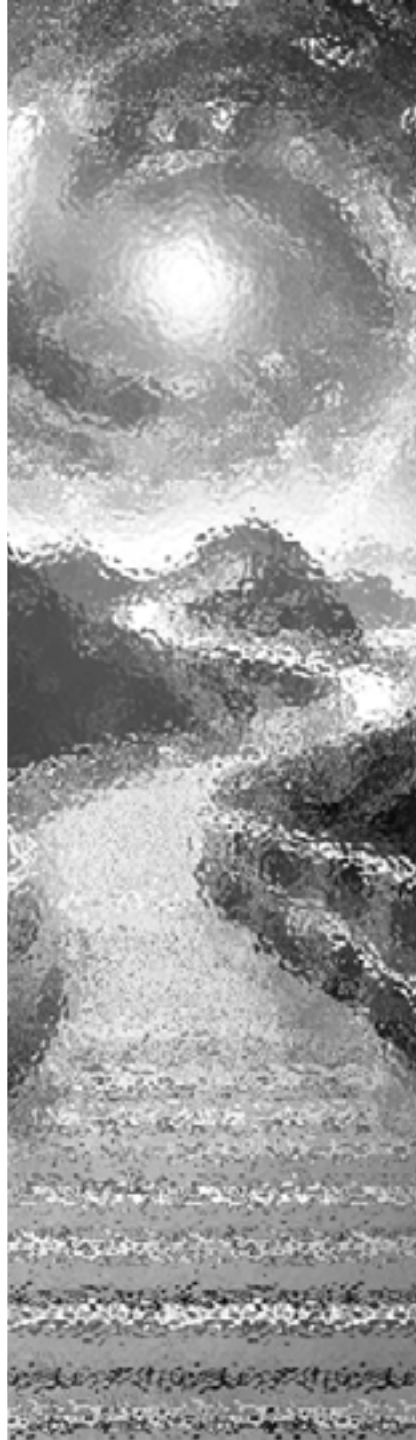


So, what does the Information Age model of learning, development, testing, and assessment look like? Let's consider six trends that will help us shape and navigate the future.

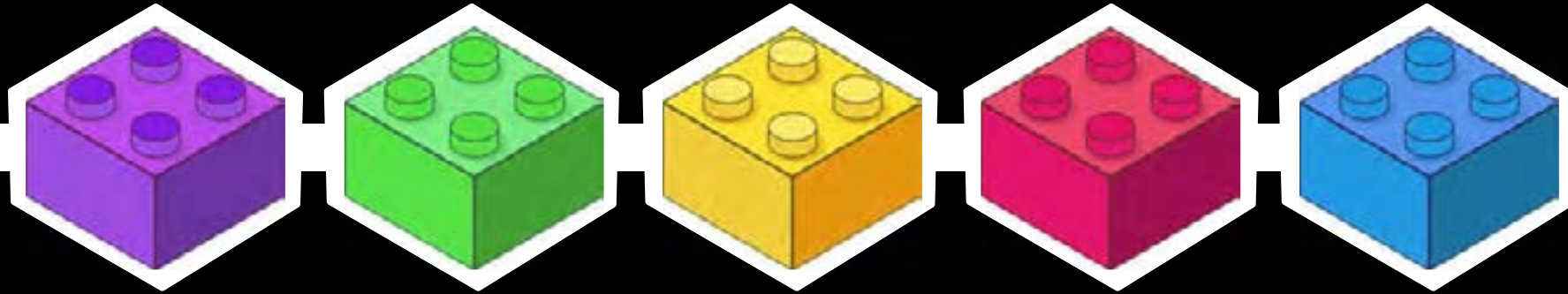




**LEARNING
ECOSYSTEMS**



First, consider the Industrial Age model...



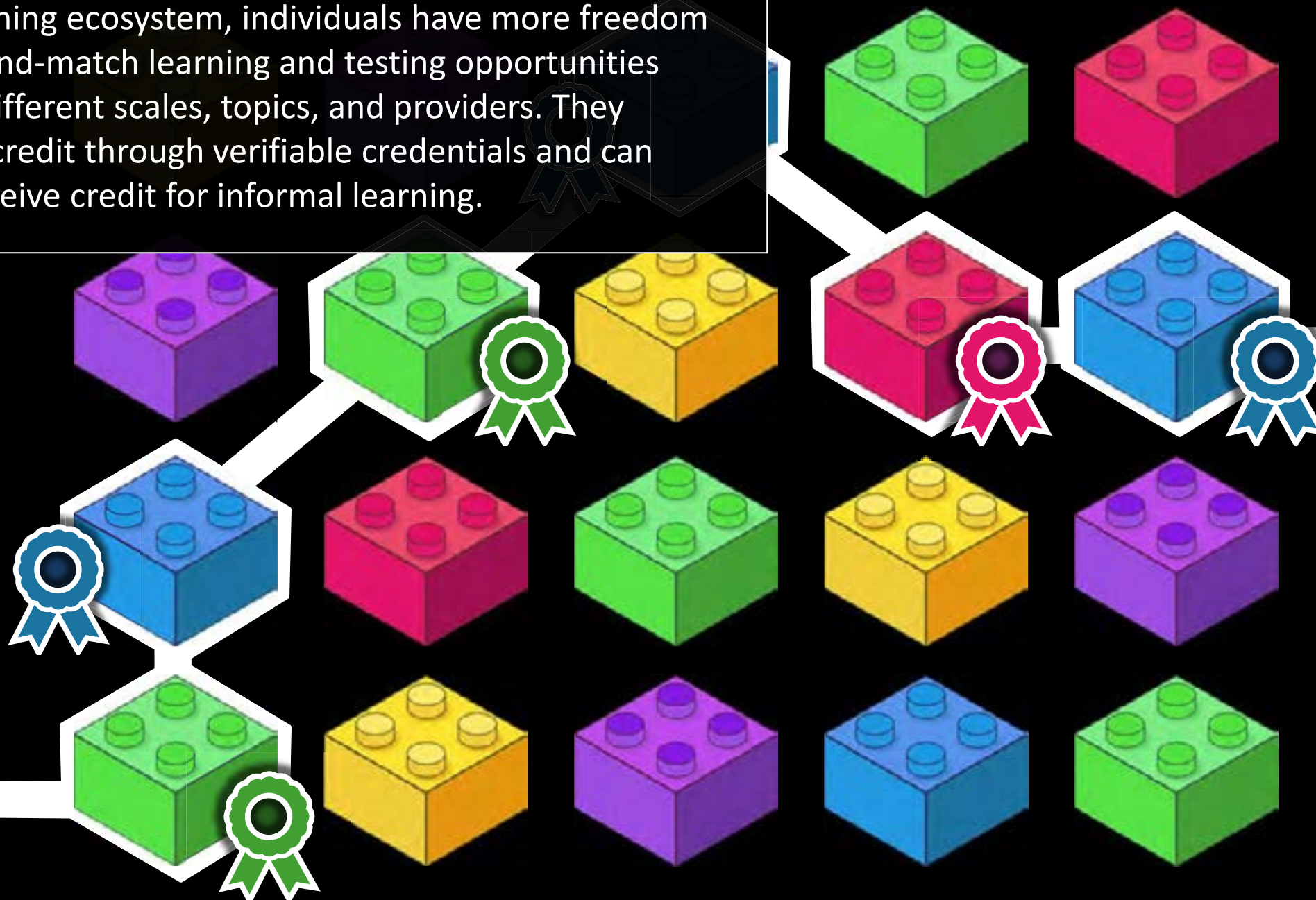
In the Industrial Age model of education and testing, someone's path is relatively linear and prescribed, with a heavy reliance on formal education and vocational training. Informal learning, such as apprenticeships, reading, and social learning, have always occurred, but they're relatively hidden to the "system."

Formal learning and testing organizations help guide people through established programs and authenticate their completions with credentials, such as diplomas.



Formal education and training are generally delivered in large chunks and frequently using a one-size-fits-all approach—that trusted, scalable, and standardized Prussian model.

In a learning ecosystem, individuals have more freedom to mix-and-match learning and testing opportunities across different scales, topics, and providers. They receive credit through verifiable credentials and can even receive credit for informal learning.

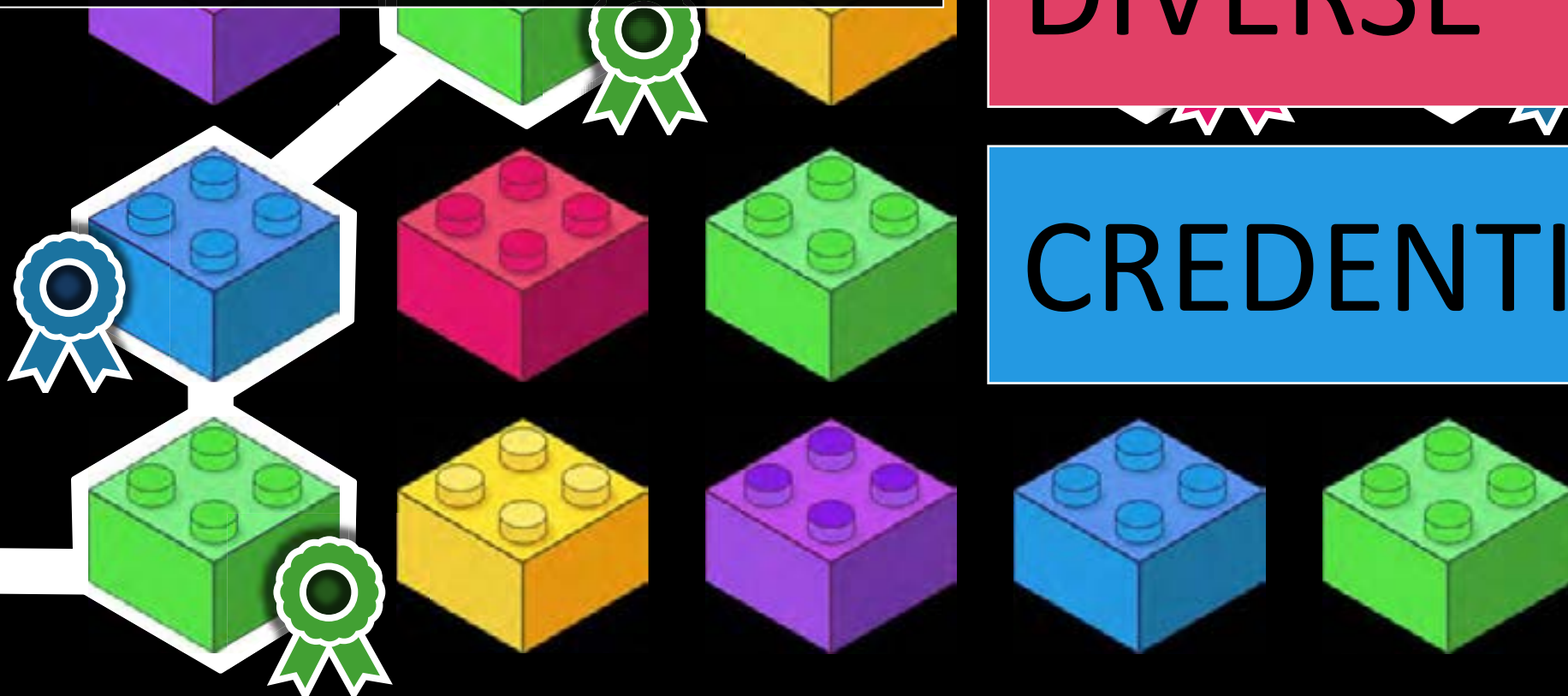


The learning ecosystem idea relies on interoperable data, so that each chunk can fit into the whole—like LEGO bricks. This data-empowered approach also enables widespread personalization (aka adaptation), both within any given experience and across the entire ecosystem—that is, personalized lifelong learning, development, testing, and assessment journeys.

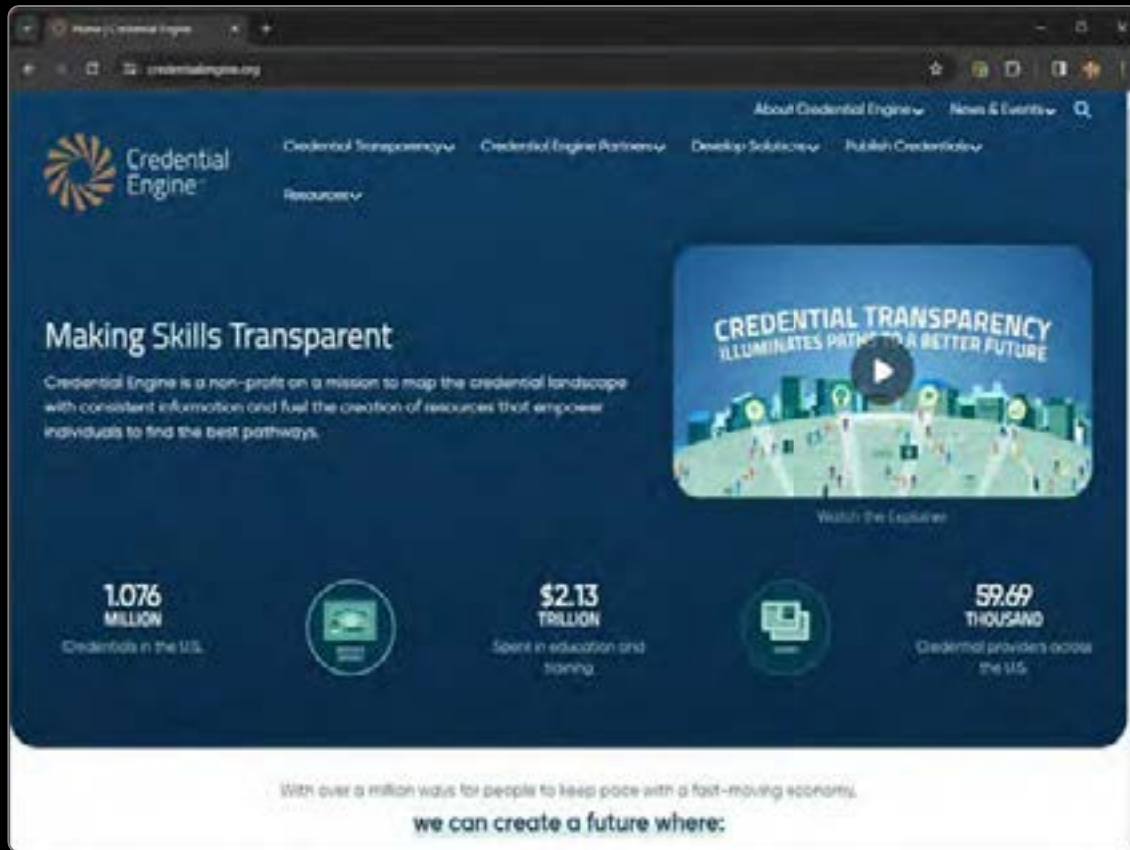
STACKABLE

DIVERSE

CREDENTIALIALED

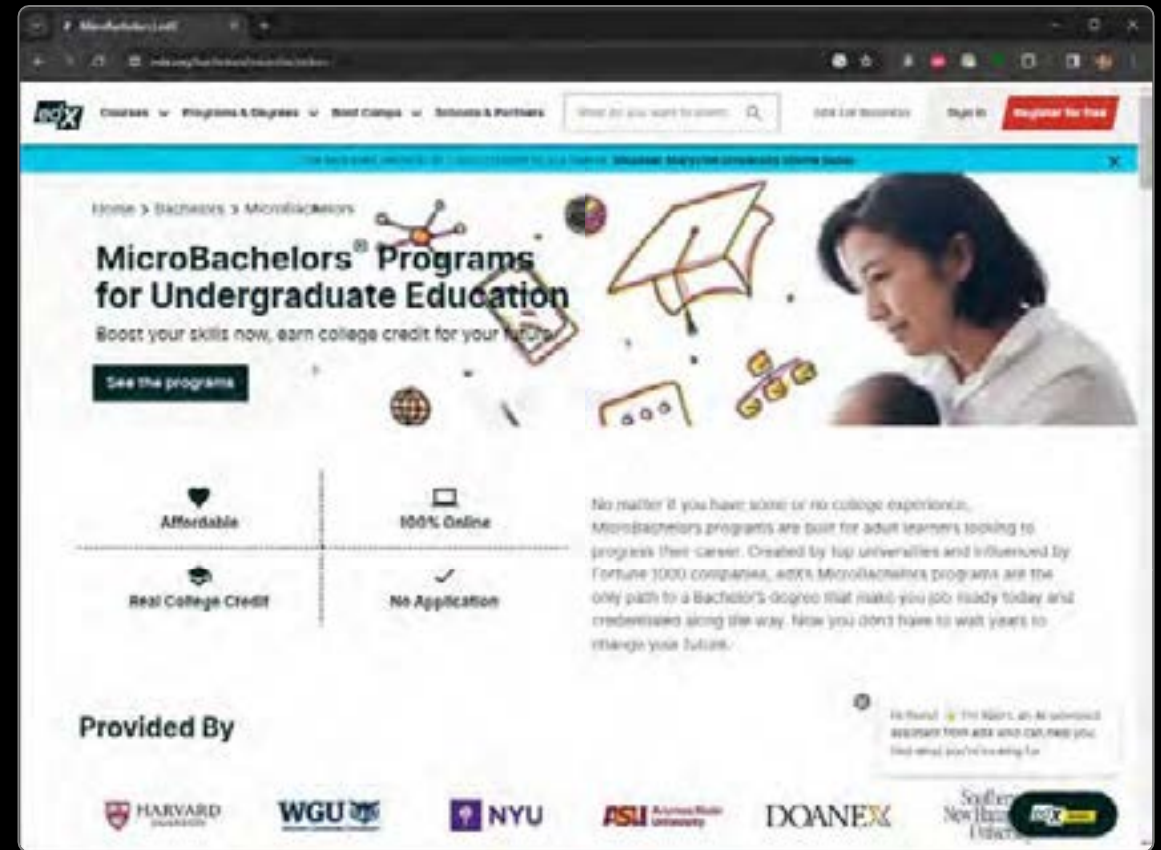


Examples of learning/testing in chunks and interoperable credentials can already be found.



The screenshot shows the homepage of Credential Engine. The header includes the logo and navigation links for 'About Credential Engine', 'News & Events', 'Credential Transparency', 'Credential Engine Partners', 'Developer Solutions', 'Publish Credentials', and 'Resources'. The main content area features a large video player with the title 'CREDENTIAL TRANSPARENCY ILLUMINATES PATHS TO A BETTER FUTURE'. Below the video, there are four statistics: '1.076 MILLION Credentials in the U.S.', '\$2.13 TRILLION Spent in education and training', and '59.69 THOUSAND Credential providers across the U.S.'. The footer contains the text: 'With over a million ways for people to keep pace with a fast-moving economy, we can create a future where:'.

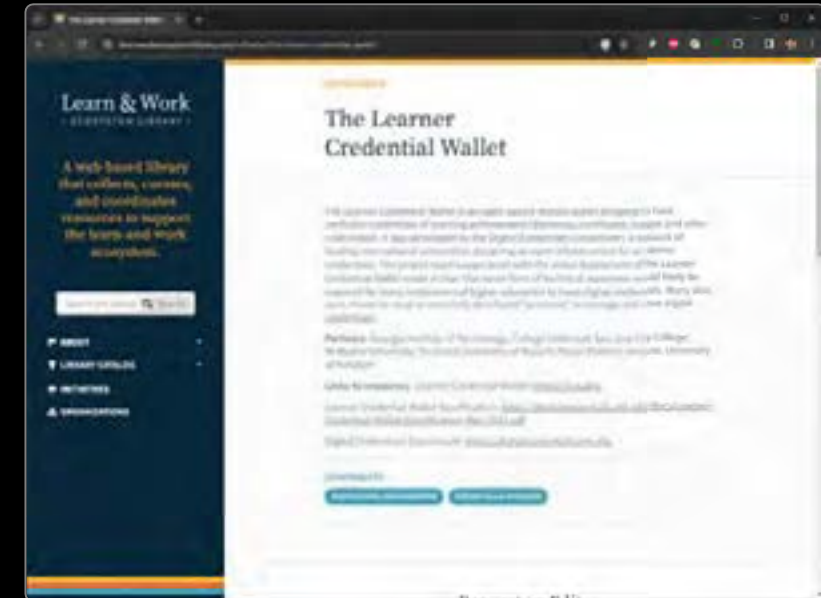
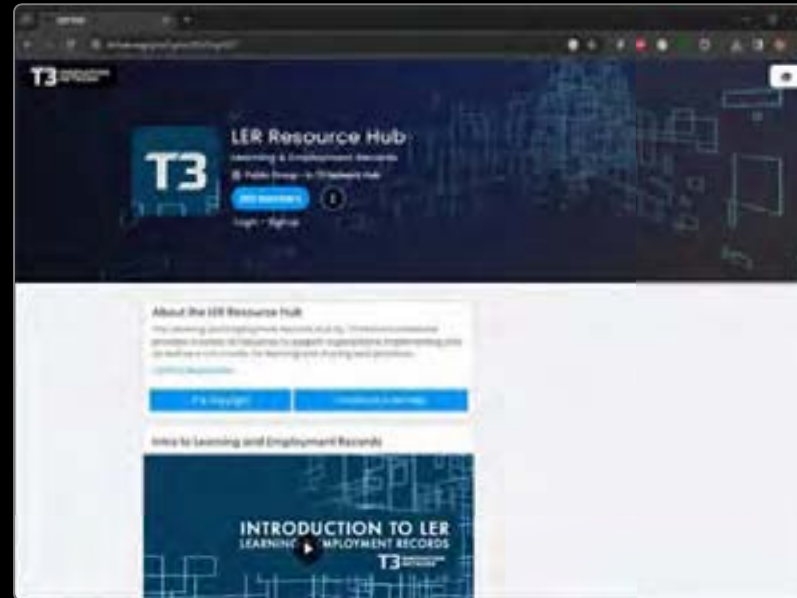
Credential Engine providing a credential marketplace • <https://credentialengine.org>



The screenshot shows the edX website page for 'MicroBachelors Programs for Undergraduate Education'. The header includes the edX logo and navigation links for 'Courses', 'Programs & Degrees', 'Short Camps', 'Sponsors & Partners', and 'Help'. The main content area features a large image of a woman with a graduation cap and the text 'MicroBachelors Programs for Undergraduate Education'. Below the image, there are four key benefits: 'Affordable', '100% Online', 'Real College Credit', and 'No Application'. A text block explains that these programs are designed for adult learners and can be completed in a shorter time frame. The footer lists 'Provided By' with logos for Harvard, WGU, NYU, ASU, DOANEXX, and Southern New Hampshire University.

edX offering stackable MicroBachelors degrees • <https://www.edx.org>

The technology for enabling LEGO-brick style interoperability across diverse systems is also rolling out.



The IEEE Learning Technology Standards Committee (LTSC) develops and maintains specifications and standards for learning technologies • <https://sagroups.ieee.org/ltsc>

The Chamber's T3 Innovation Network is also working on Learning Employment Records for lifelong learning—to enable the learning ecosystem • <https://lerhub.org>

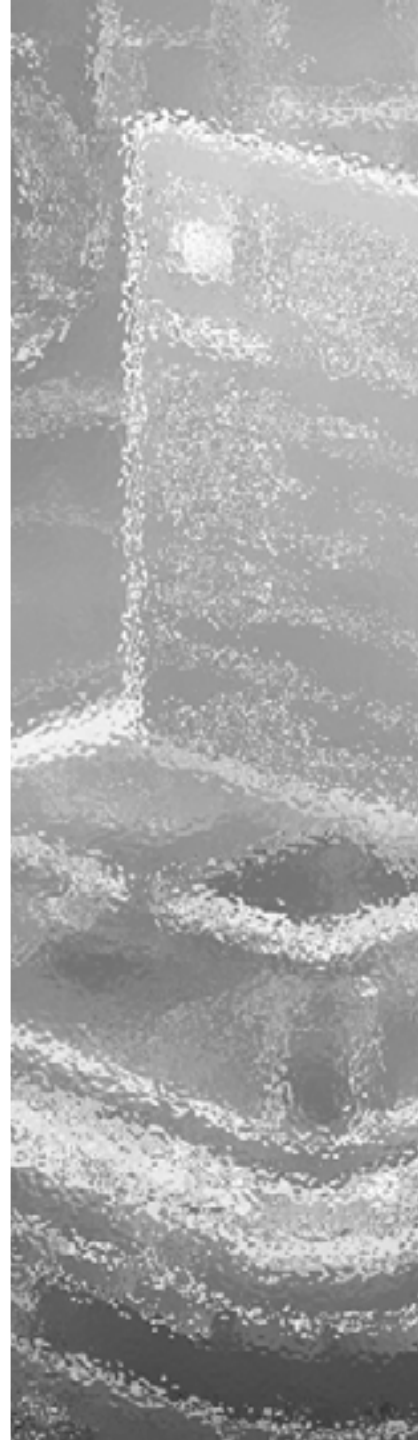
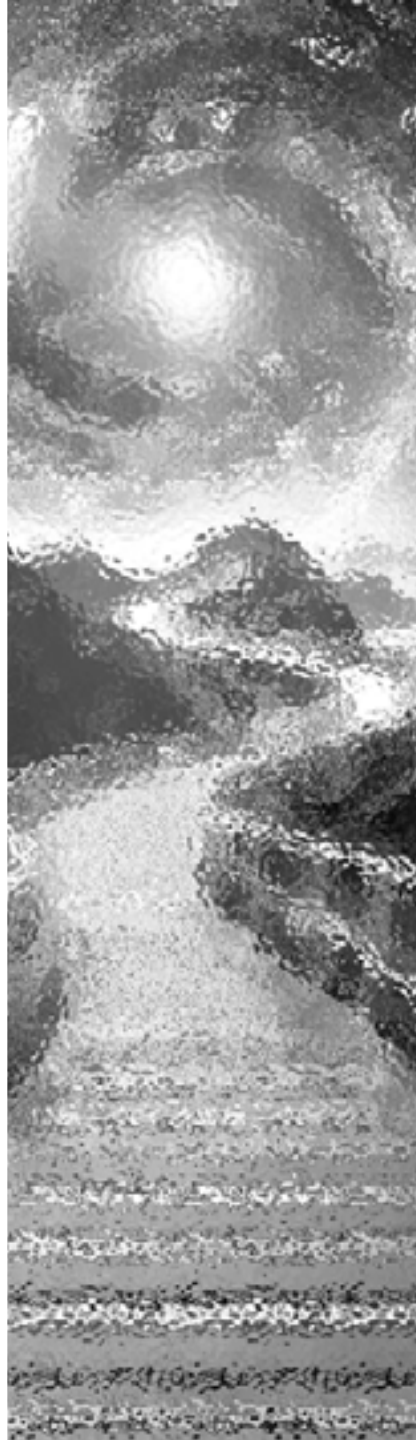
Learner Credential Wallets are already publicly available and notable groups, such as MIT and the W3C are working on these technologies • <https://opportunityatwork.org>



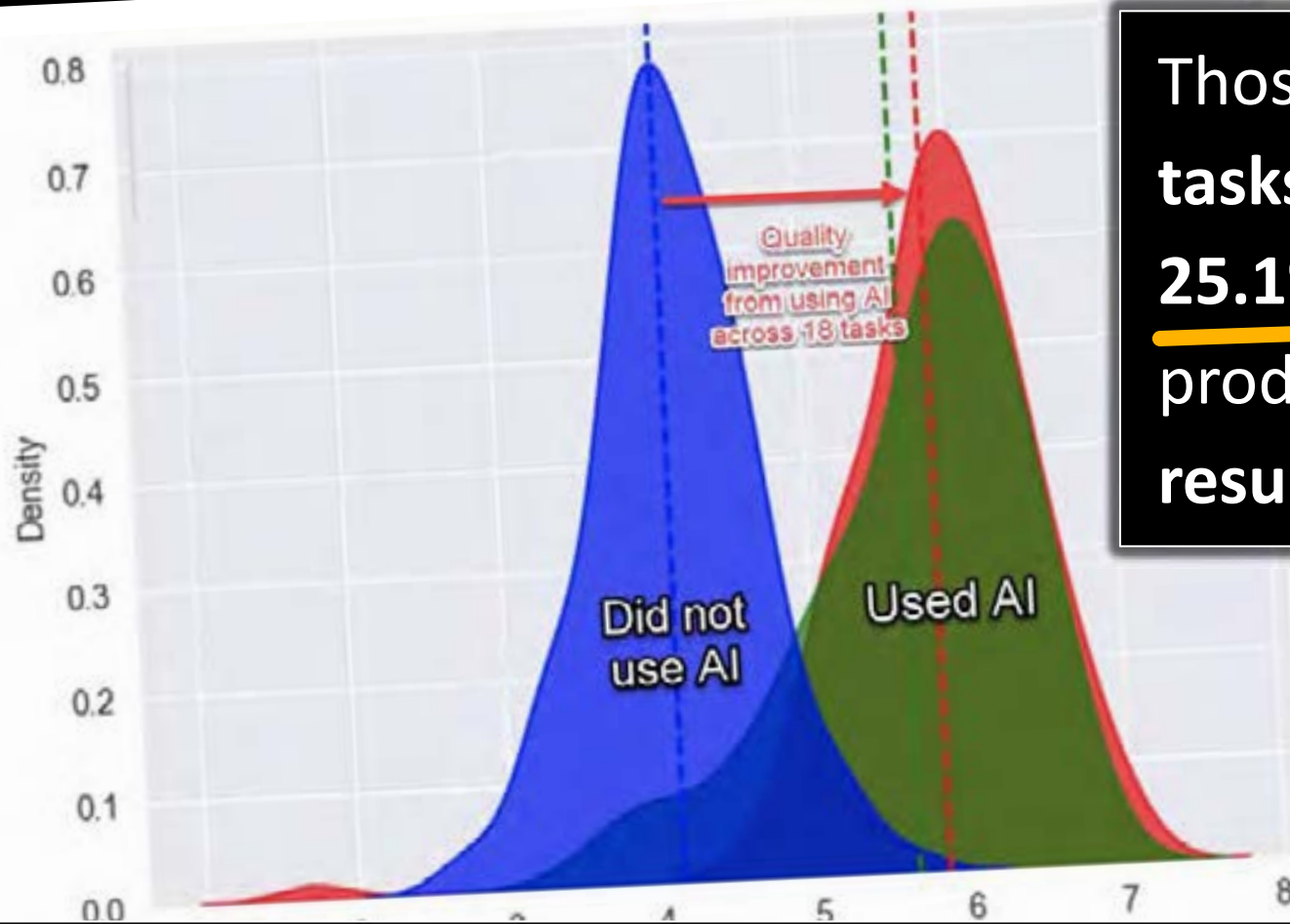
**LEARNING
ECOSYSTEMS**



**GEN AI
CONTENT**



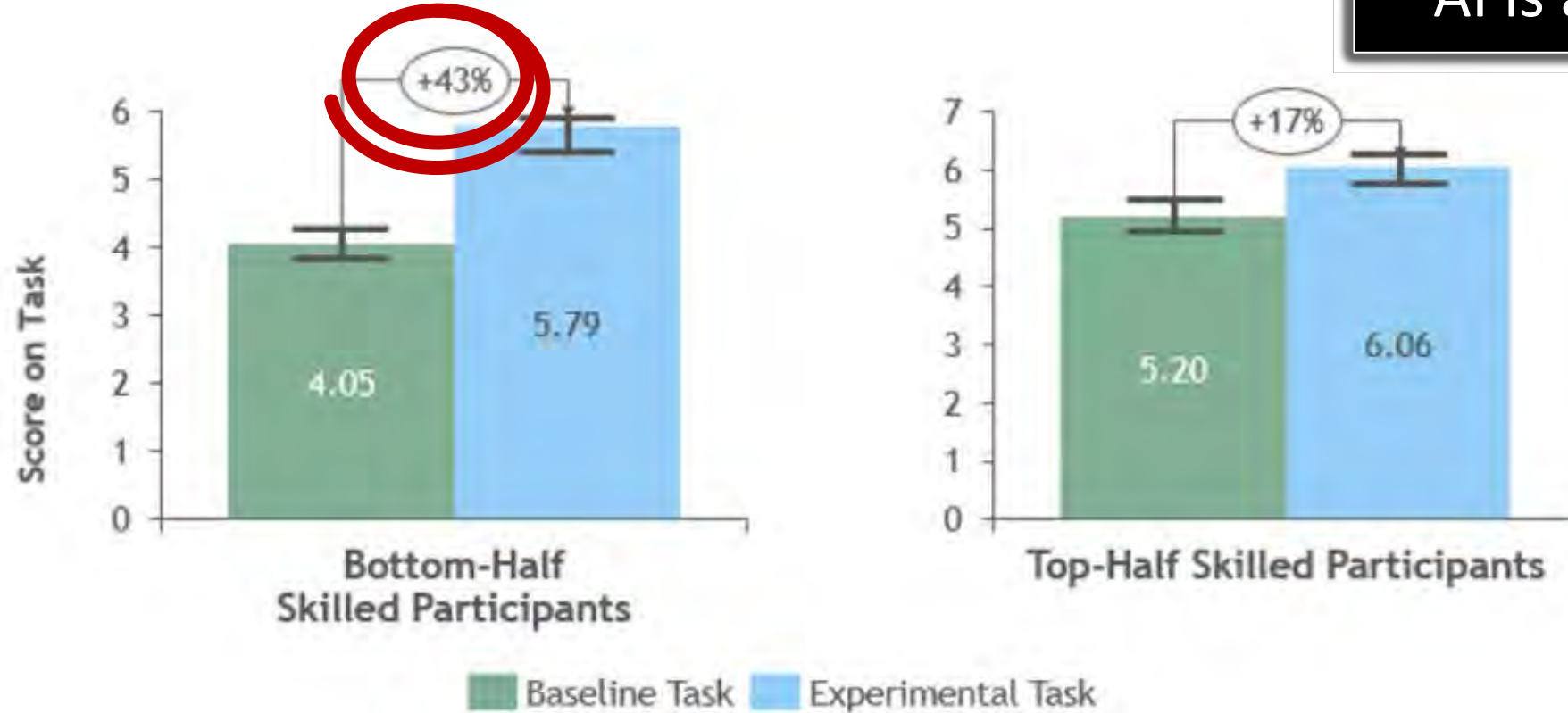
Those using AI finished **12.2% more tasks** on average, **completed tasks 25.1% more quickly**, and produced **40% higher quality results** than those without



Mollick, E. (2023, Sept. 16). "Centaur and Cyborgs on the Jagged Frontier." Research reports from the Boston Consulting Group. <https://www.oneusefulthing.org/p/centaurs-and-cyborgs-on-the-jagged>

Ethan Mollick reports the results of a study that examined professional workers at an elite consulting company using (or not using) ChatGPT-4 assistance across 18 different tasks. Consultants using Generative AI outperformed those who did not—by a lot and on every dimension measured.

AI is a skill equalizer

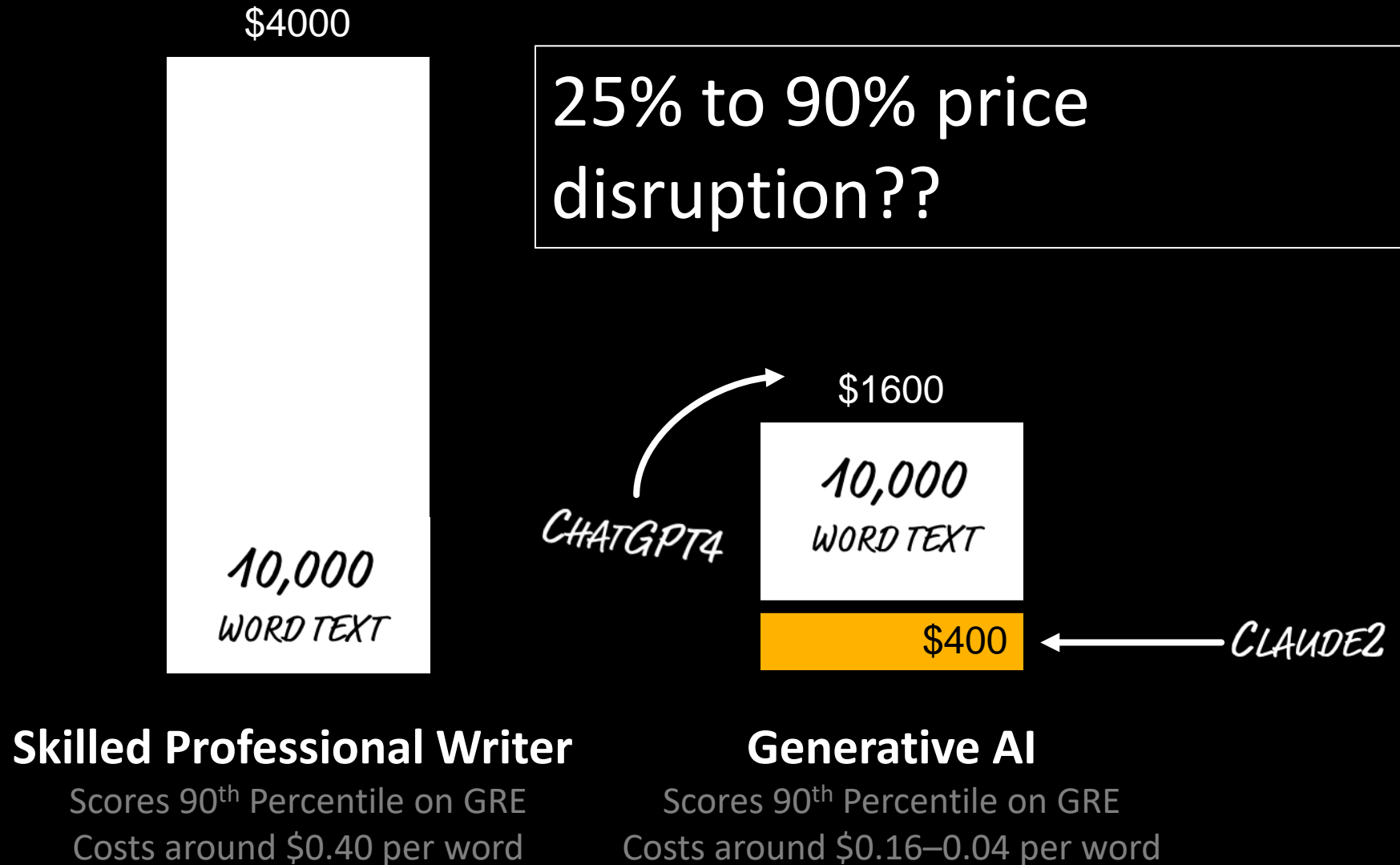


Mollick, E. (2023, Sept. 16). "Centaur and Cyborgs on the Jagged Frontier." Research reports from the Boston Consulting Group. <https://www.oneusefulthing.org/p/centaurs-and-cyborgs-on-the-jagged>

The benefit of using AI assistance was especially pronounced in the less-skilled half of participants.

Philip Stelter examined the cost of Generative AI compared to equivalent human creators. ChatGPT and other popular large language models, such as Claude2, score in the 90th percentile on the Graduate Record Examinations (GRE) for writing.

A similarly skilled human writer charges around \$0.40 per word, while large language models cost around \$0.16–0.04 per word—potentially a huge cost-savings.



Stelter, C. (2023, July 26). "Fast, Cheap and Good: How much more productive can generative AI make writing?" <https://www.linkedin.com/pulse/fast-cheap-good-how-much-more-productive-can-ai-make-writing-stelter>



TEXTBOOKS

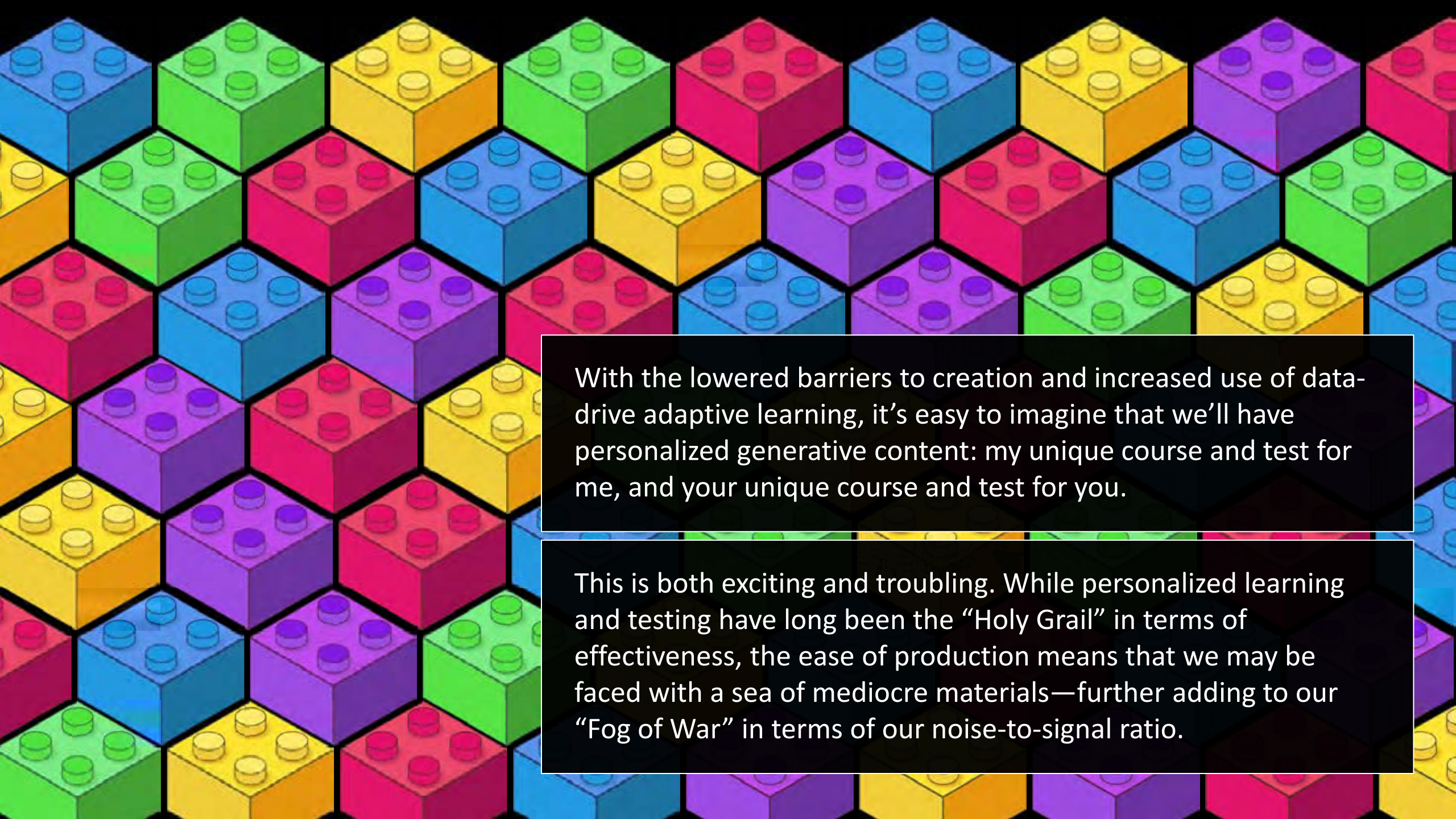
25% to 90% price
disruption??

COURSEWARE

DIGITAL MEDIA

TESTS

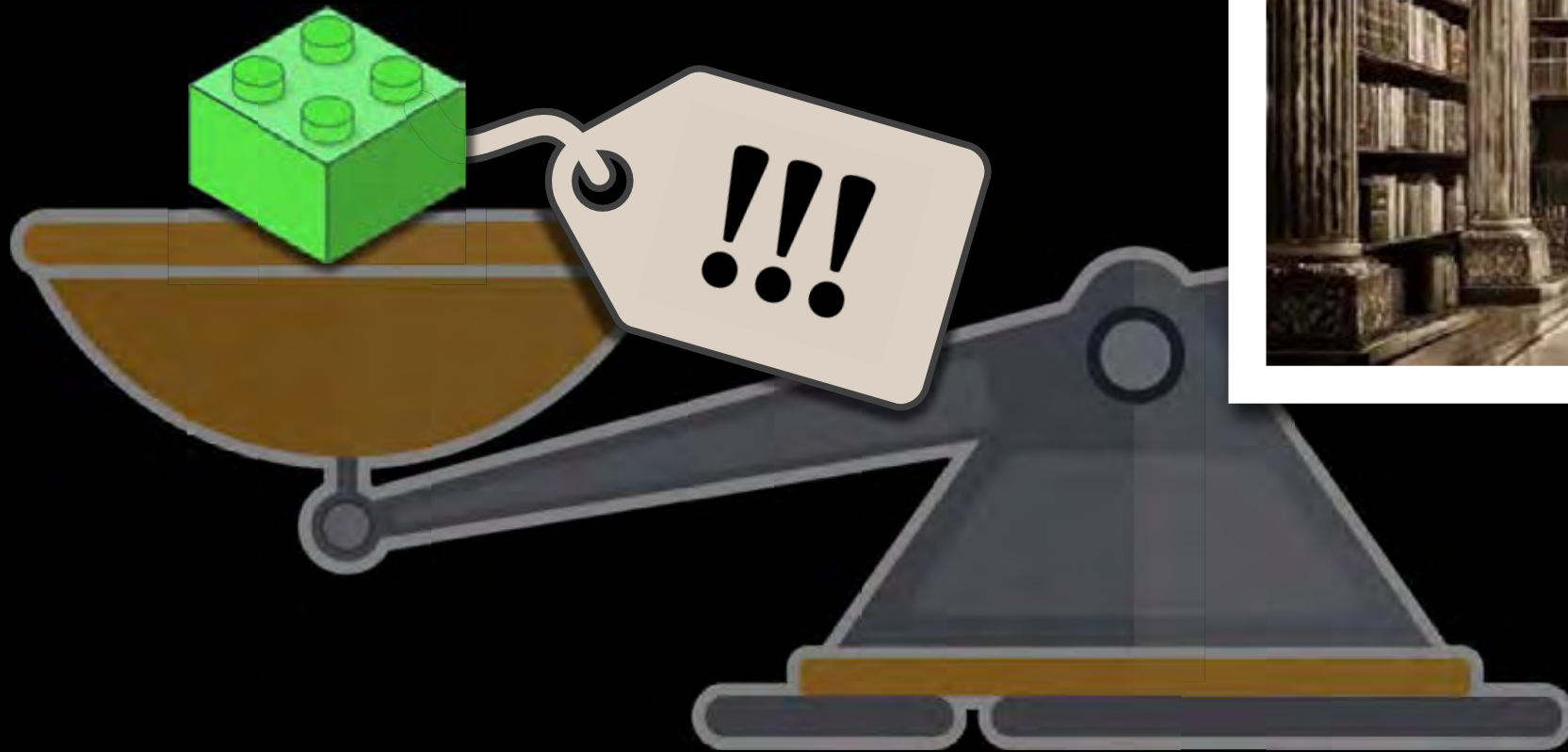
Generative AI technologies promise to create massive efficiencies—and business disruptions—across learning, development, testing, and assessment markets. What are the implications of a 90% reduction in the cost and time required to create courseware or textbooks?



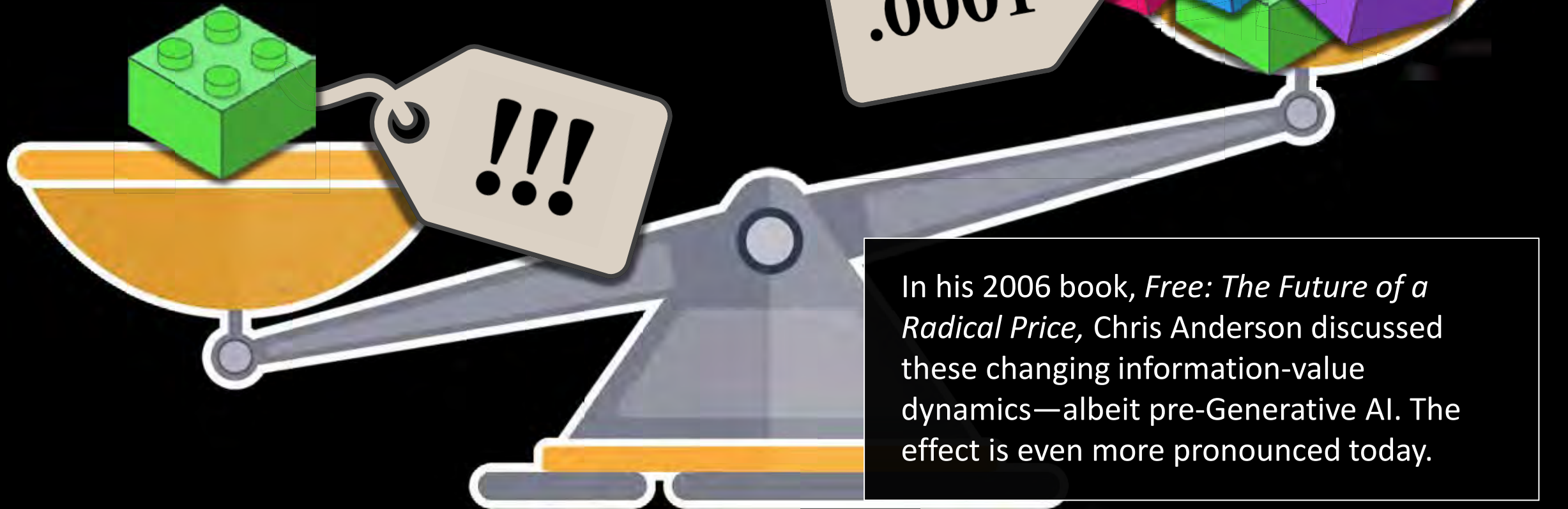
With the lowered barriers to creation and increased use of data-drive adaptive learning, it's easy to imagine that we'll have personalized generative content: my unique course and test for me, and your unique course and test for you.

This is both exciting and troubling. While personalized learning and testing have long been the "Holy Grail" in terms of effectiveness, the ease of production means that we may be faced with a sea of mediocre materials—further adding to our "Fog of War" in terms of our noise-to-signal ratio.

And as we rapidly build all these new products, the relative value of each is diminished. Once upon a time, information was scarce, and as a result, each scroll of ancient knowledge was prized—protected behind massive doors and only accessible by the societal elite. Information as treasure.



Today, information is so plentiful that each product is nearly valueless in comparison to the whole. This devaluation of generic information is particularly evident for digital goods like online discussions, e-news, and software, where copying and distributing them is effortless.



In his 2006 book, *Free: The Future of a Radical Price*, Chris Anderson discussed these changing information-value dynamics—albeit pre-Generative AI. The effect is even more pronounced today.

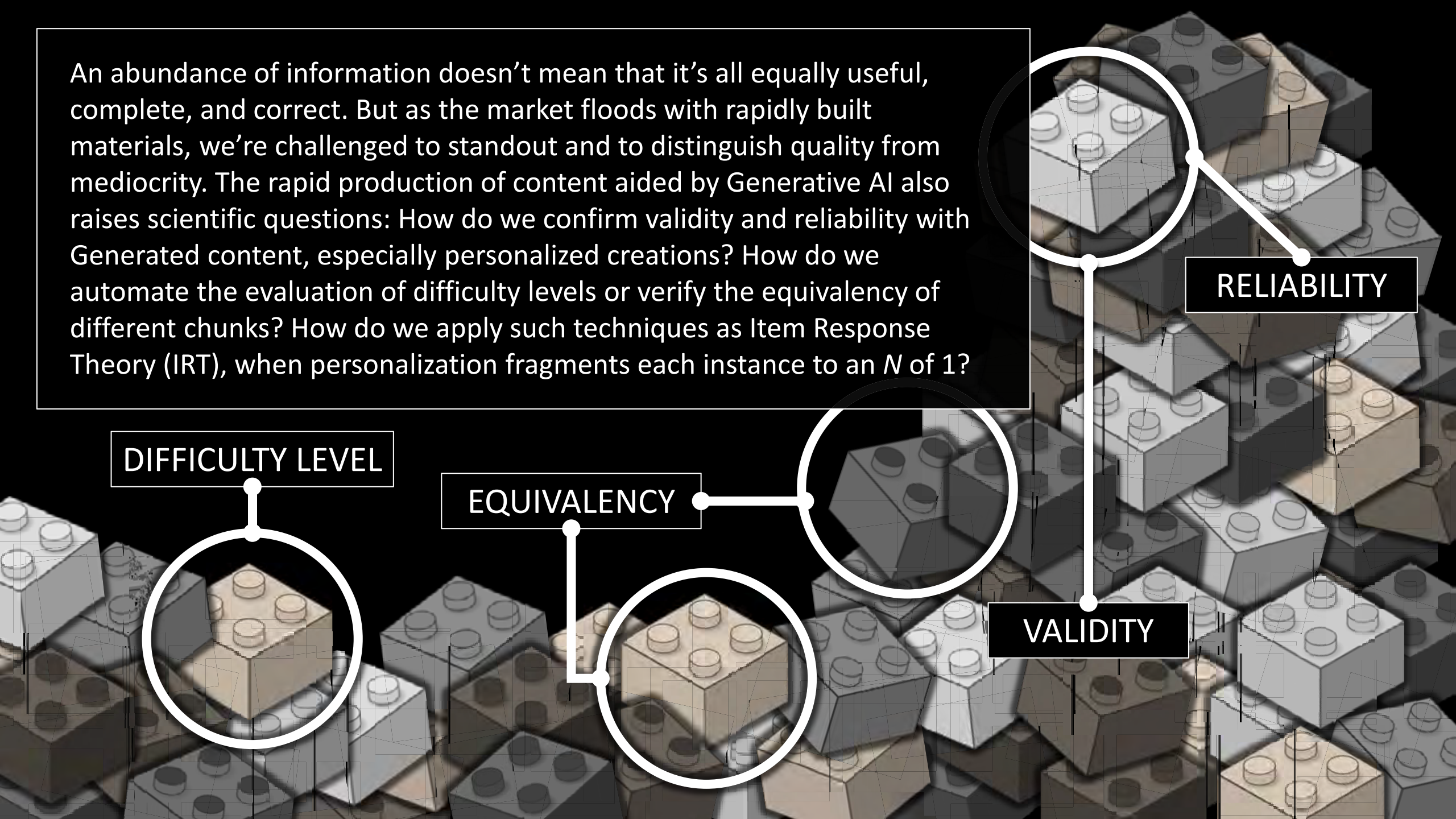
An abundance of information doesn't mean that it's all equally useful, complete, and correct. But as the market floods with rapidly built materials, we're challenged to stand out and to distinguish quality from mediocrity. The rapid production of content aided by Generative AI also raises scientific questions: How do we confirm validity and reliability with Generated content, especially personalized creations? How do we automate the evaluation of difficulty levels or verify the equivalency of different chunks? How do we apply such techniques as Item Response Theory (IRT), when personalization fragments each instance to an N of 1?

DIFFICULTY LEVEL

EQUIVALENCY

RELIABILITY

VALIDITY





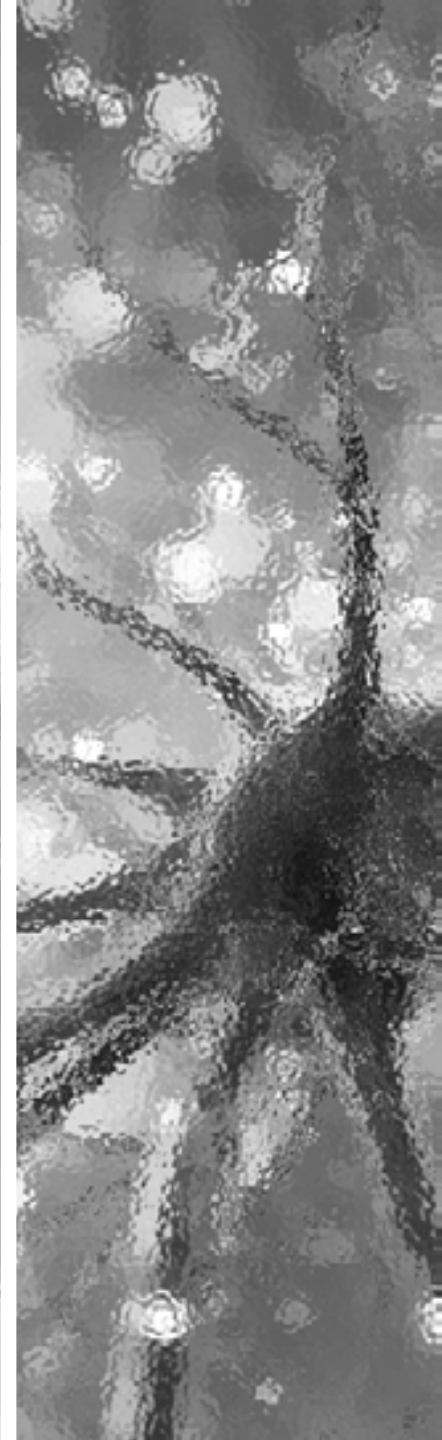
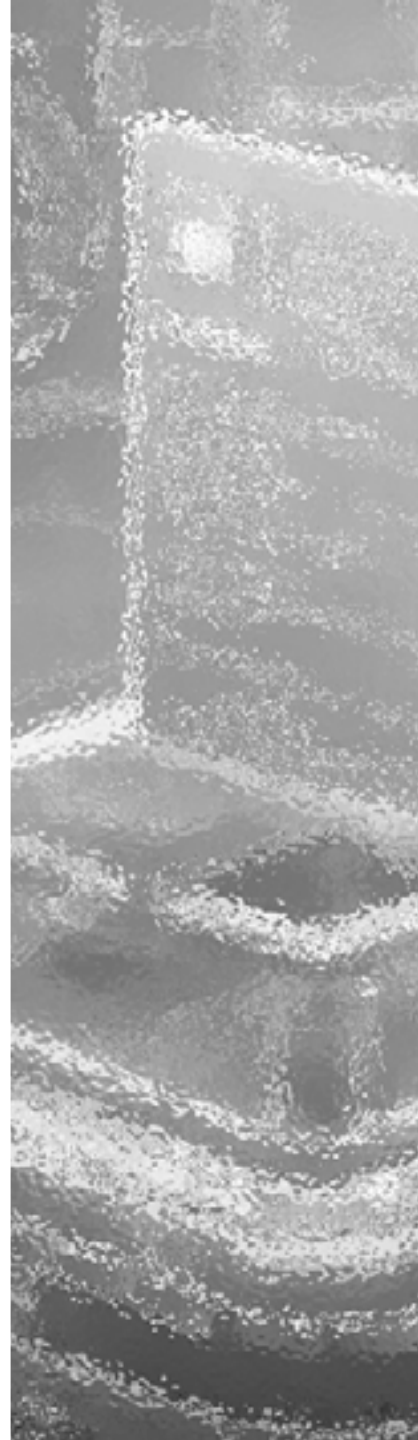
**LEARNING
ECOSYSTEMS**



**GEN AI
CONTENT**



**LIFELONG
LEARNING**



44%
of workers'
core skills
will change

...by 2027 (in the next 5 years)

60%
of workers
will require
training

THE 60-YEAR CURRICULUM

New Models for Lifelong Learning
in the Digital Economy

EDITED BY CHRISTOPHER J. DEDE
AND JOHN RICHARDS



There's growing recognition that the pace of change in business and technology will require individuals to learn, upskill, and develop across their entire (working) lives.

In *The 60-Year Curriculum*, Chris Dede and John Richards make the case for lifelong learning. The term “60-Year Curriculum” was coined by Gary Matlin, from the University of California, Irvine. It refers to a new perspective on lifelong (or at least career-long) learning, driven by the rapidly evolving context jobs, technologies, and market dynamics.

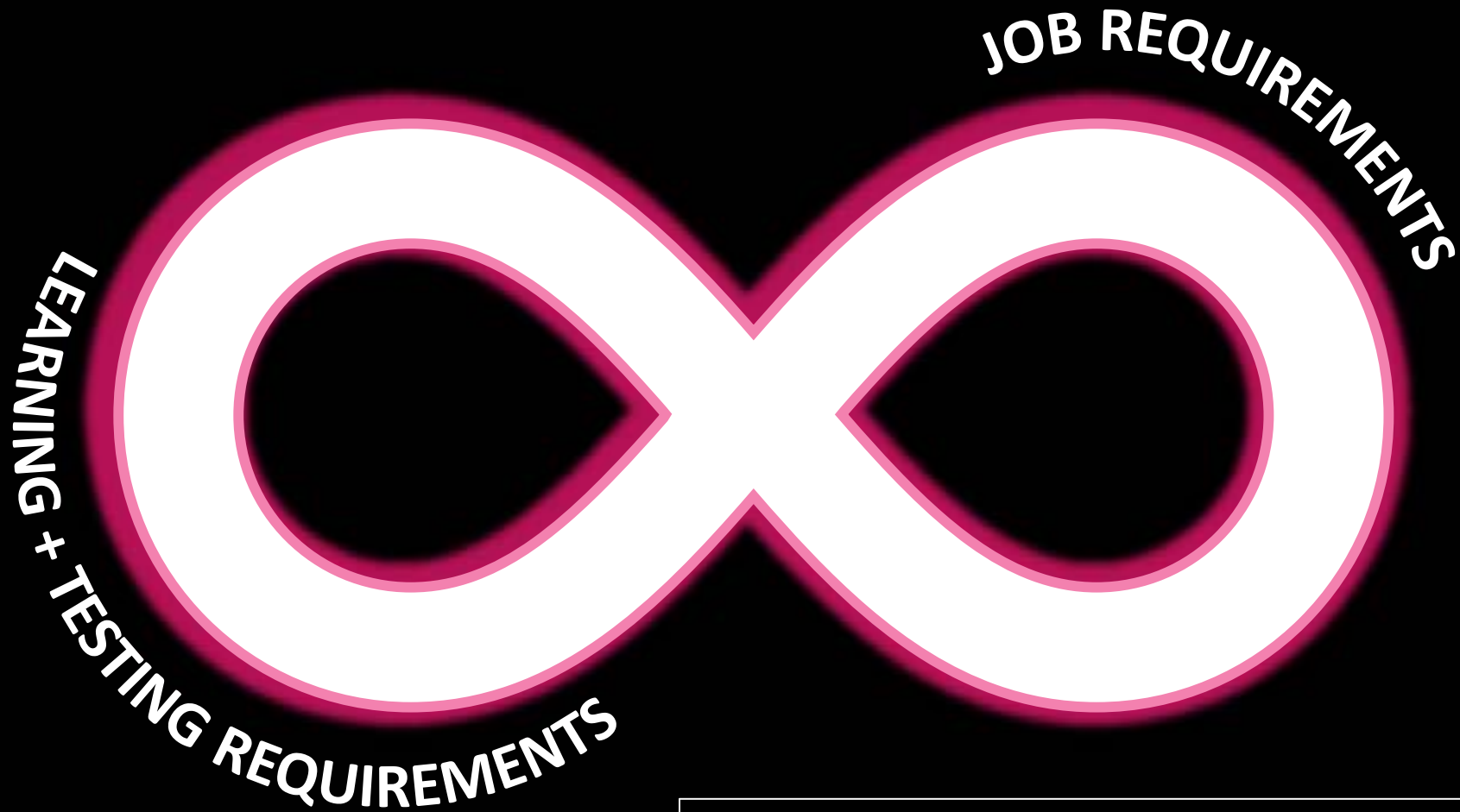
Dede, C. & Richards, J. (2020). *The 60-Year Curriculum: New Models for Lifelong Learning in the Digital Economy*. United Kingdom: Taylor & Francis.

For an online summary, see: Richards, J. & Dede, C. (2020, October). The 60-Year Curriculum: A Strategic Response to a Crisis, *Educause Review*, 4, 25–38.

<https://er.educause.edu/articles/2020/10/the-60-year-curriculum-a-strategic-response-to-a-crisis>

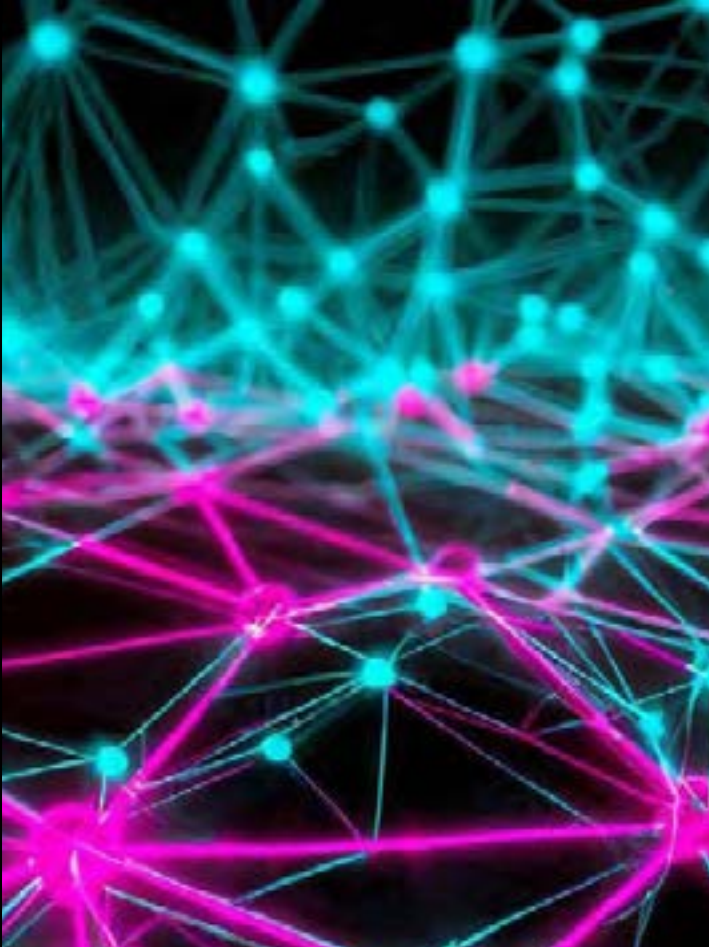


It's not feasible for us all to spend 60 years in a Prussian-esque classroom. That's *not* what the 60-year curriculum means. Rather, we'll need to find more efficient, effective, and transparent ways to learn, grow, rehearse, and test—integrated throughout our lives.



We can also expect to see a strengthening of the symbiosis between job requirements and learning/testing requirements. That doesn't necessarily mean everything needs to be about work, but rather that some expectations are set to evolve...

Reliable and timely alignment



Reliable predictions of transfer



Learning-Rehearsal-Performance

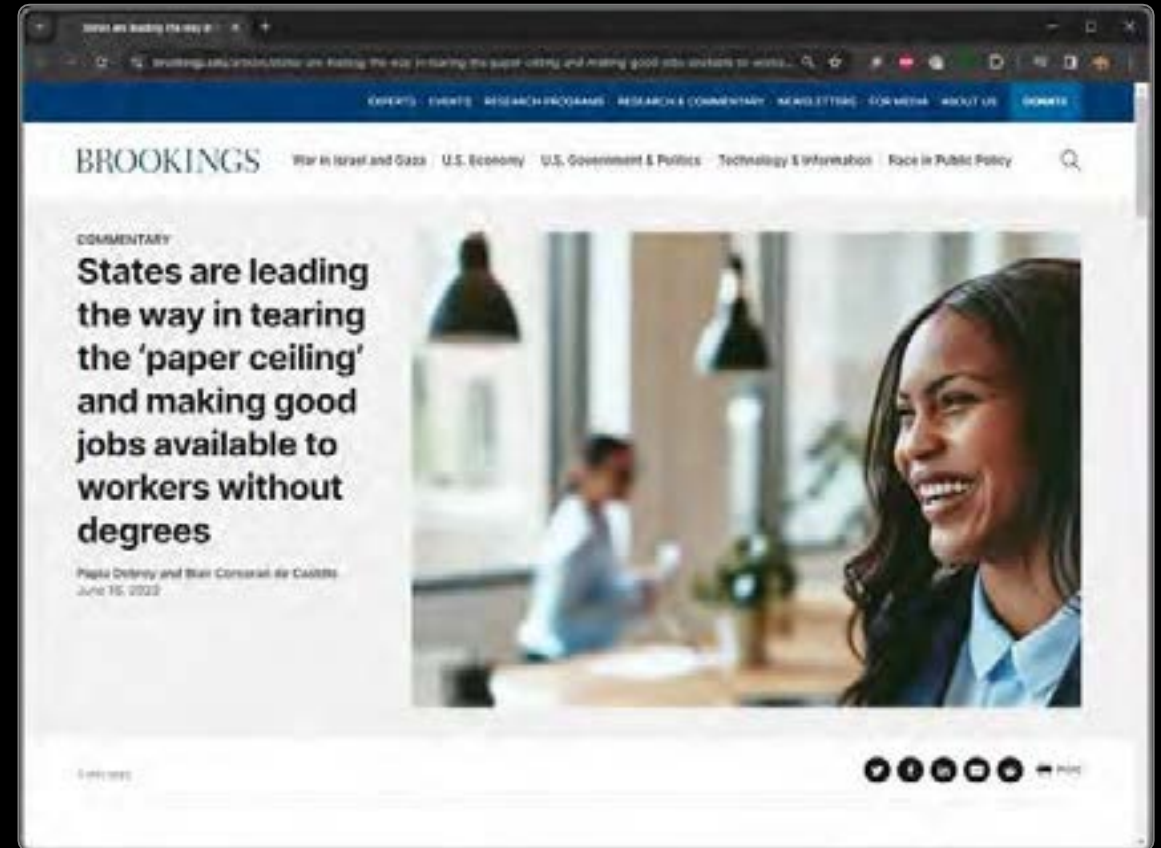


- Instructional offerings and desired job/task performance needs to become more tightly and reliably aligned, up to date, and validated.
- Competency assessments need to reliably correlate with authentic performance, so that we're better able to predict transfer of learning and prescribe recommended next steps for personal/professional development or career advancement.
- We'll see growing overlap among learning, rehearsal, performance, and assessment (more videogame tutorial and less Prussian classroom).

The lifelong learning model also necessarily recognizes that learning also happens outside classrooms.

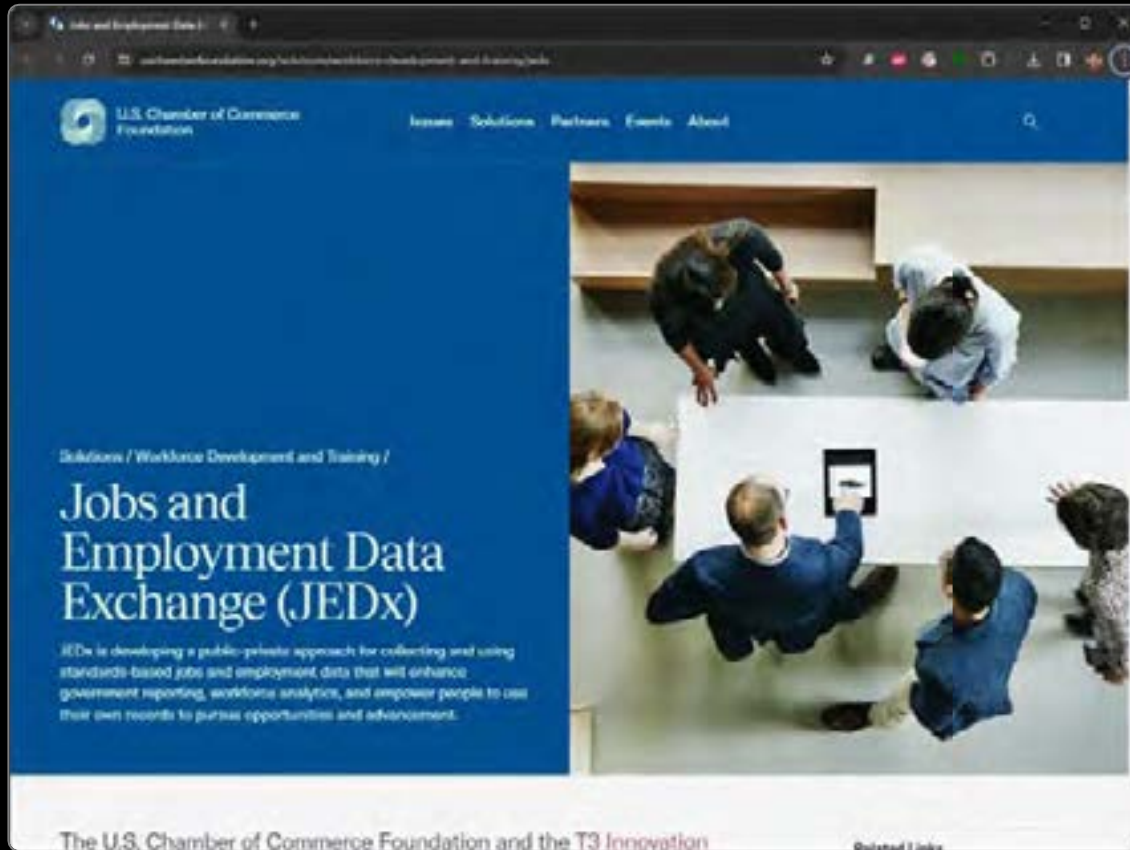


Increasing awareness and support for those
Skilled Through Alternative Routes •
<https://opportunityatwork.org>



US Government HR systems swapping higher-
education requirements for STARS •
<https://www.brookings.edu>

Technologies, processes, and policies for enabling the 60-Year Curriculum are already manifesting.



US Chamber of Commerce Foundation working on data standards for jobs • <https://www.uschamberfoundation.org>



ACE awarding credit for prior work and life experiences • <https://www.acenet.edu>



LEARNING ECOSYSTEMS



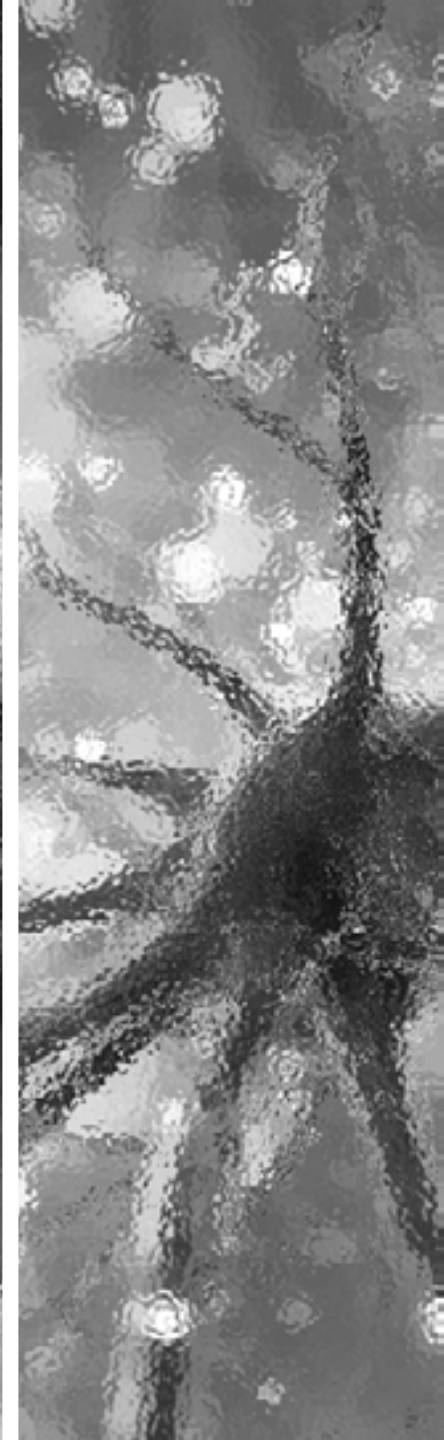
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LIFELONG LEARNING



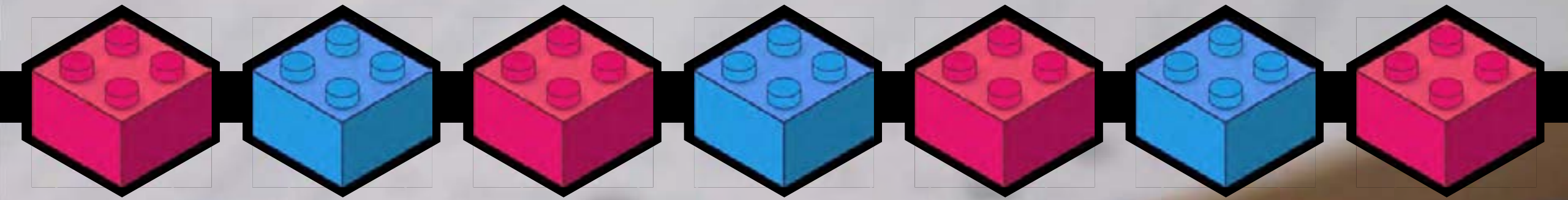
TESTING AND ASSESSMENT



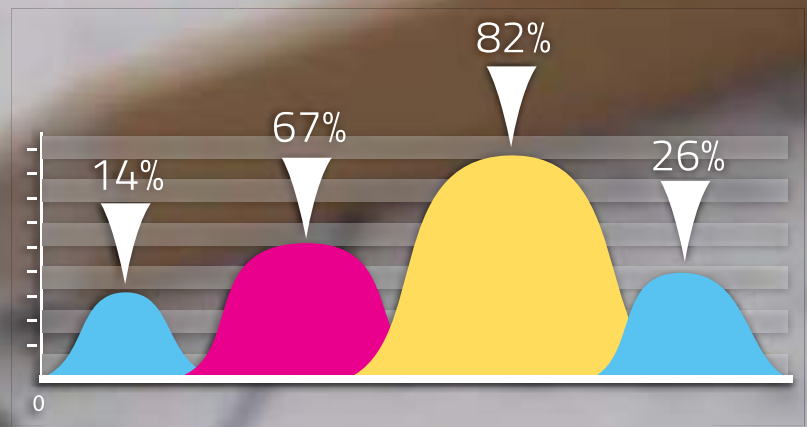
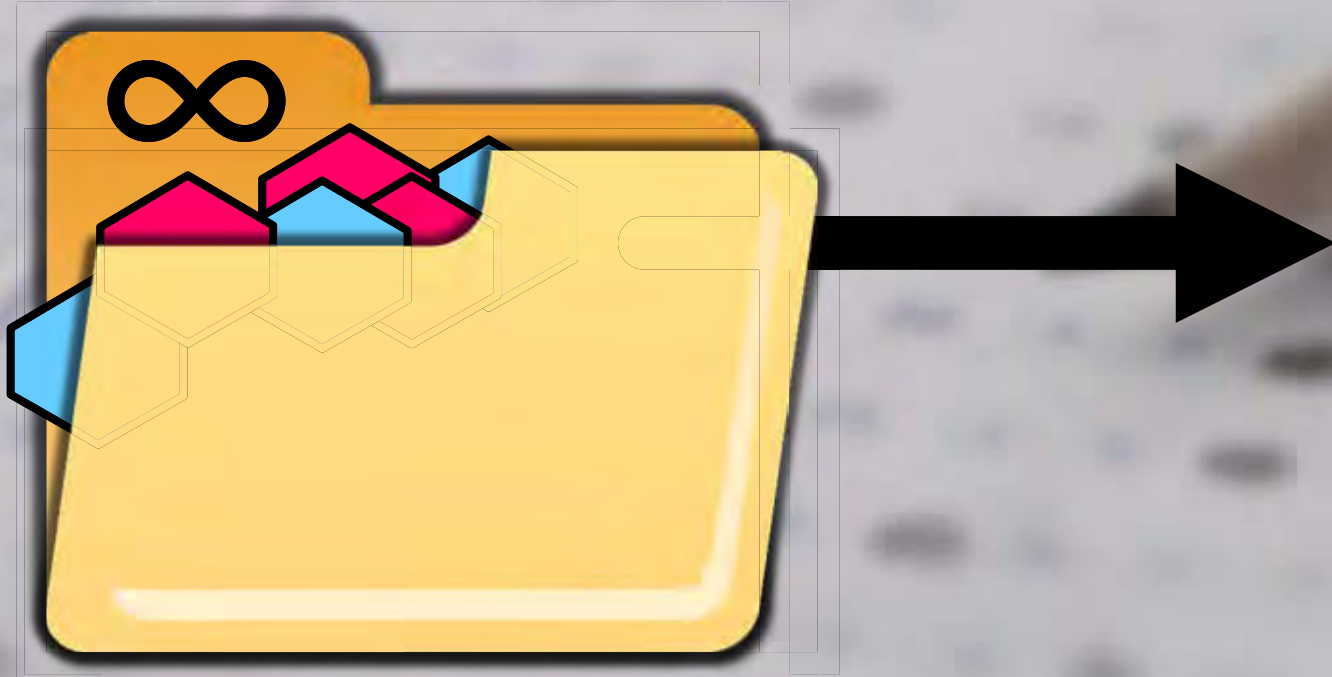
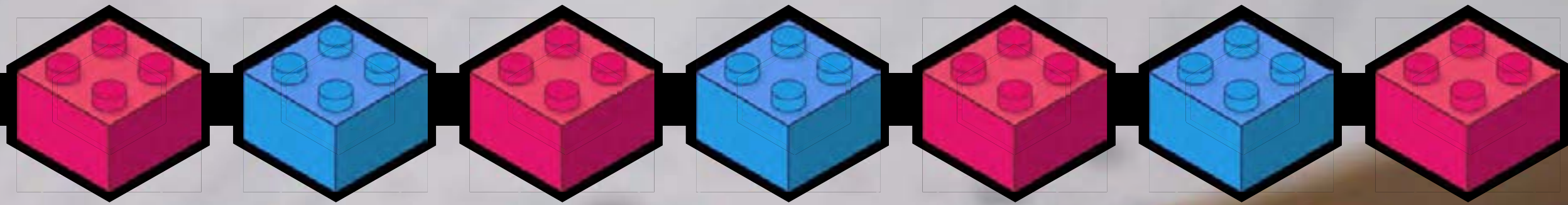
Classically, testing and assessment have often relied on artificial snapshots of capability (such as paper-based tests of applied skill or self-report measures of noncognitive factors), separated from authentic performance contexts and bounded to a single moment in time.

As we move toward a LEGO-brick style of learning, with more diverse paths and experiences (including both formal and informal learning), we'll need new ways to conduct assessments that are more ecological (*in situ*), authentic, stackable, and transparent.





Fortunately, there are many new opportunities for integrated, continuous, and multifactor measures. Data can also be compiled over periods of time (versus snapshots), informing descriptive analyses and allowing future tests and assessments to be tailored based on those areas where there is uncertainty in individuals' learner-worker portfolios.



**MULTIMODAL
ASSERTIONS
LEARNING ANALYTICS**



INSTRUMENTATION



CLICKSTREAM



A/V/SPATIAL SENSORS



NEUROPHYSIOLOGICAL

STEALTH ASSESSMENT

Integrated and multifactor measures can be transparent to those who are learning or being assessed. Computers and other devices can be instrumented to collect data, such as monitoring real-time behaviors and performance (e.g., with cameras, clickstream, and wearable sensors). Multiple simultaneous data feeds can be aggregated to give more reliable results, and learning analytics can be used to make inferences from the aggregate data.



DESCRIPTIVE

INFERENTIAL

PREDICTIVE

PRESCRIPTIVE

These diverse, multimodal data can also be collected over time and processed via Learning Analytics methods to provide descriptive, as well as inferential, predictive, and prescriptive analyses, both immediately and longitudinally.



**LEARNING
ECOSYSTEMS**



**GEN AI
CONTENT**



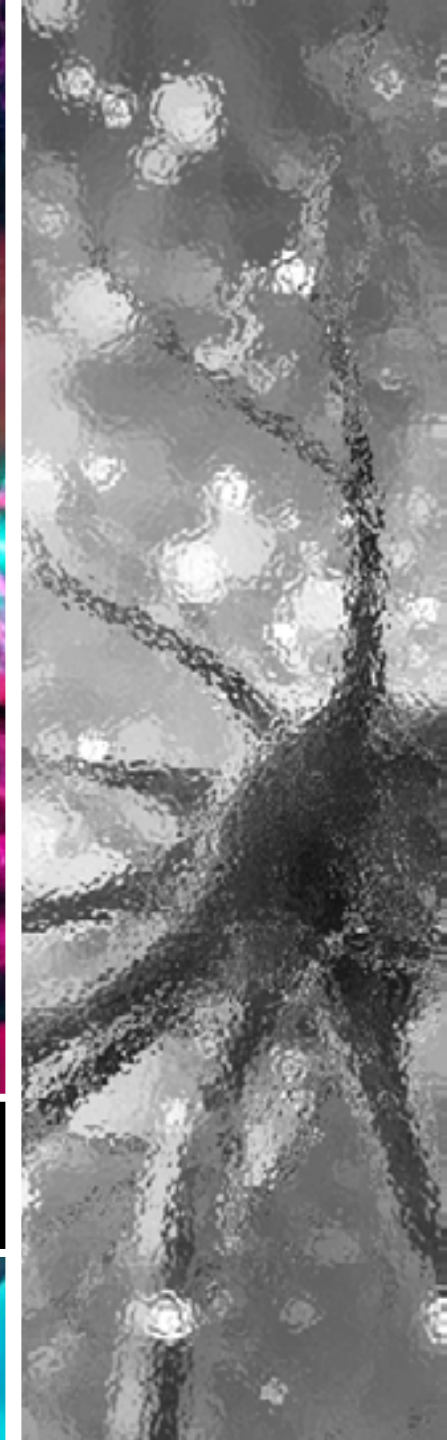
**LIFELONG
LEARNING**



**TESTING AND
ASSESSMENT**



**AUGMENTED
INTELLIGENCE**

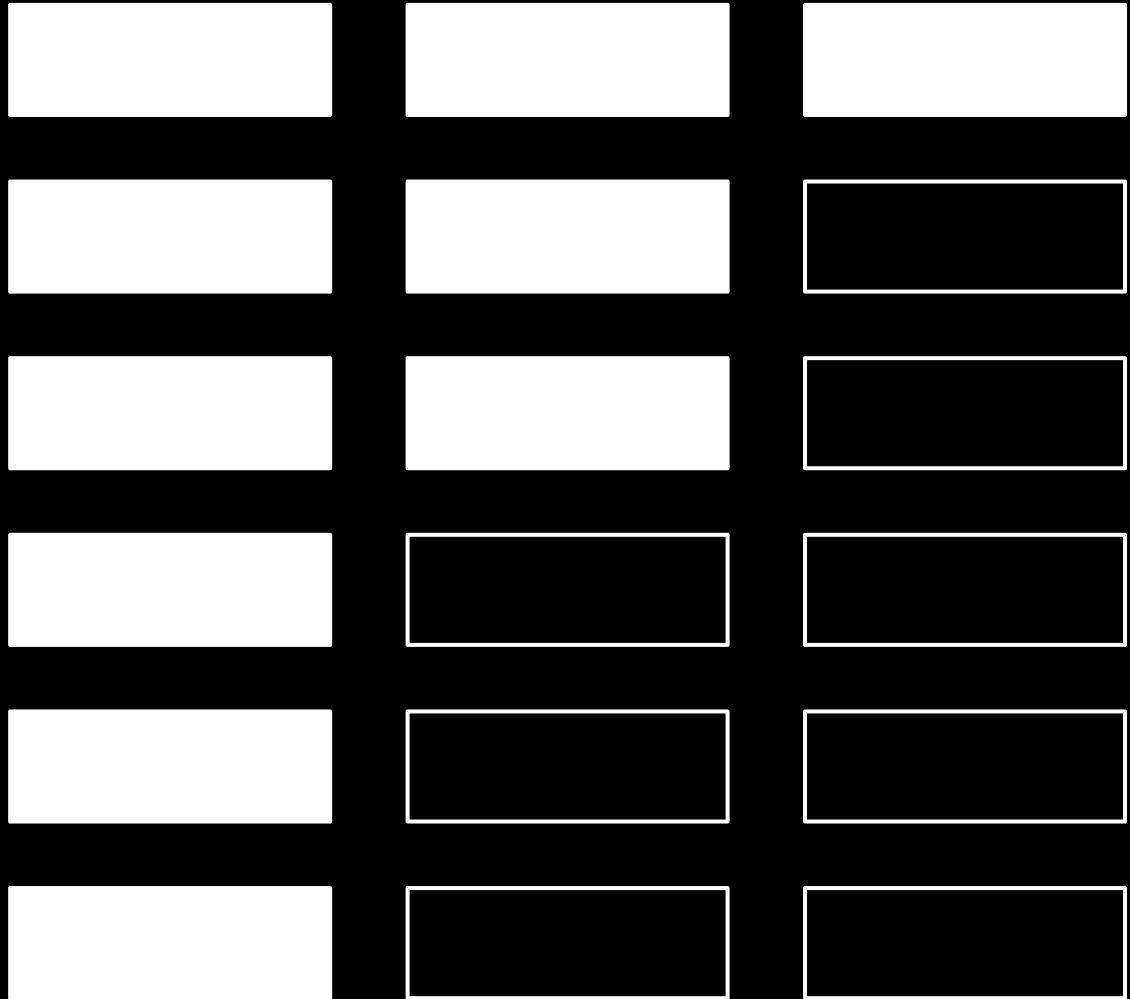


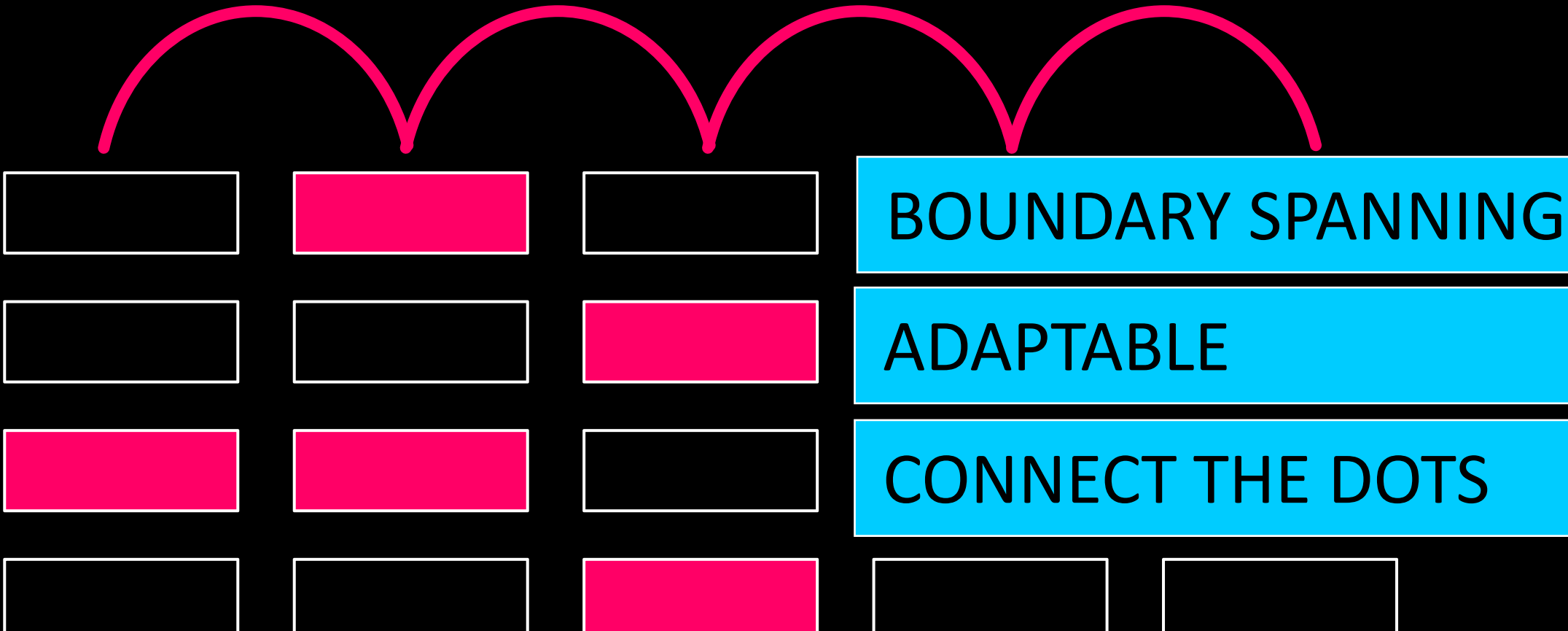
Once upon a time, expertise was mainly defined as deep knowledge and skill in a single vertical, with, perhaps, some supplementary skills in adjacent verticals.

Today and into the future, we can expect to see more augmented intelligence—the integration of AI with human intelligence to enhance our cognitive work.

In combination, people and programs can accomplish amazing feats, better than either alone. Even average individuals paired with AI teammates have shown that they can best (human) grandmasters or standalone algorithms.

EXPERTISE





Today, many organizations are seeking more diverse “experts” who have a smattering of knowledge and skills across different domains. These are “expert generalists.” Expert generalists are in high demand due to the increasing interdependency of systems and—most notably—the increasing use of technology to supplement our knowledge and skills. An armchair “pseudo expert” from today with the aid of Google and Wikipedia could likely compete against any deep, traditional expert from the Prussian era.

Philip Tetlock helped popularize the “Fox and Hedgehog” analogy.

Foxes represent expert generalists; they tend to pursue many ends, often unrelated and even contradictory, and they’re typically skeptical of grand theories.

Hedgehogs are narrow experts. They relate everything back to a single central vision, are eager to extend their theories into new domains, and are relatively confident in their abilities.

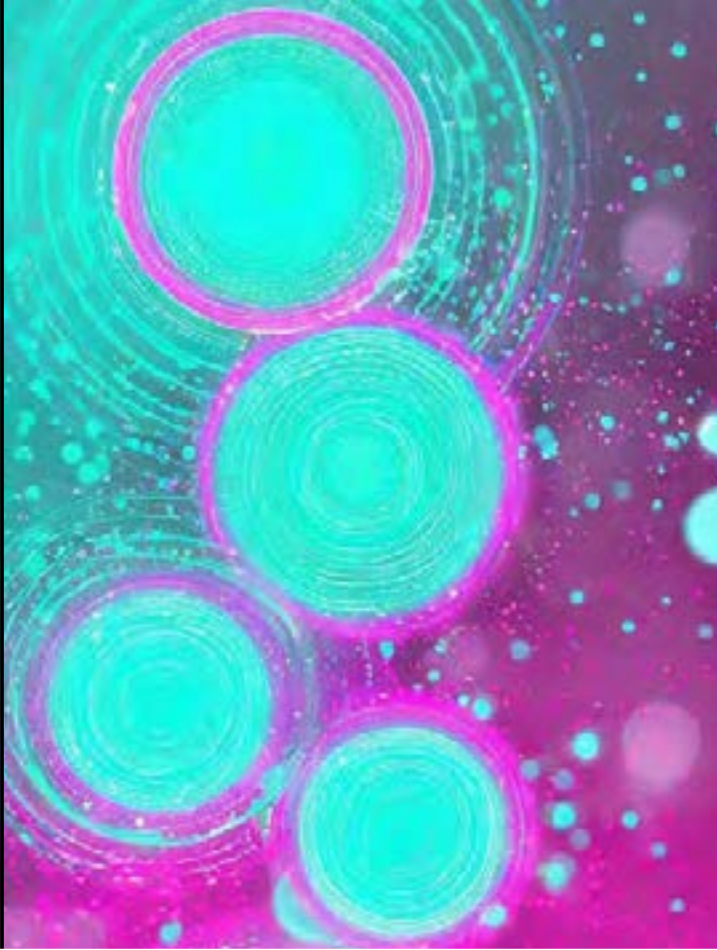


EXPERT GENERALISTS



The fox knows many things;
the hedgehog one great thing

Collapsing Boundaries



Developing Youth and Novices



“Cheating”



These trends encourage us to think about: • the boundaries between learning, rehearsal, evaluation, and performance spaces. • Our notions of how to develop novices into experts. If AI can simply perform the lower-level cognitive actions, then how do we provide enough practice for novices to develop their organic knowledge and skills? Do they even need those augmented knowledge and skills anymore? • And the notion of “cheating” —on homework, on tests, and at work.

“Writing will create forgetfulness in the learners’ souls, because they will not use their memories...”

“Cheating”



SOCRATES

It’s worth remembering that when calculators, sundials, and printing presses were first introduced, people thought it would be the end of world (or at least the end of education) each time. Socrates even expressed some “moral panic” over the invention of writing, as captured by Plato from *the Phaedrus*. So, let’s not be too hasty to cast aspersions on AI “cheating.”



LEARNING ECOSYSTEMS



GEN AI CONTENT



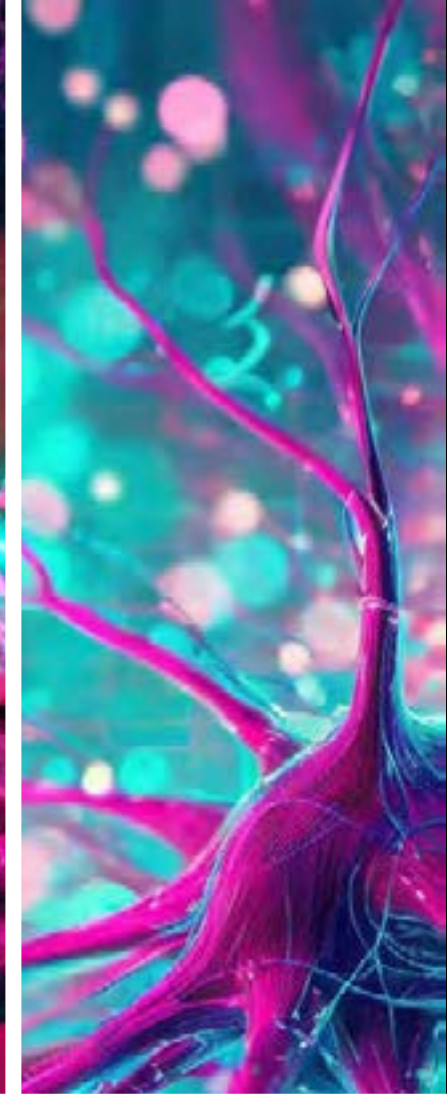
LIFELONG LEARNING



TESTING AND ASSESSMENT



AUGMENTED INTELLIGENCE



LEARNING ENGINEERING



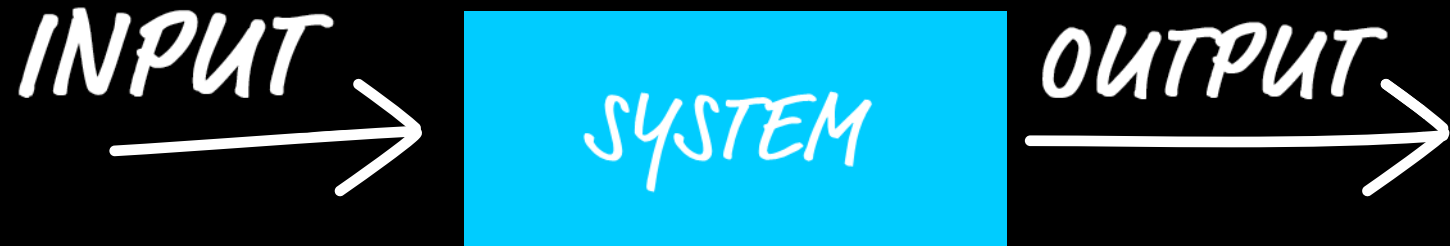
learning engineering ['lərnɪŋ ,enjə'nɪrɪŋ]

Learning engineering is a **process** and practice that applies the **learning sciences**, using **human-centered engineering** design methodologies and **data-informed** decision-making, to support learners and their development.

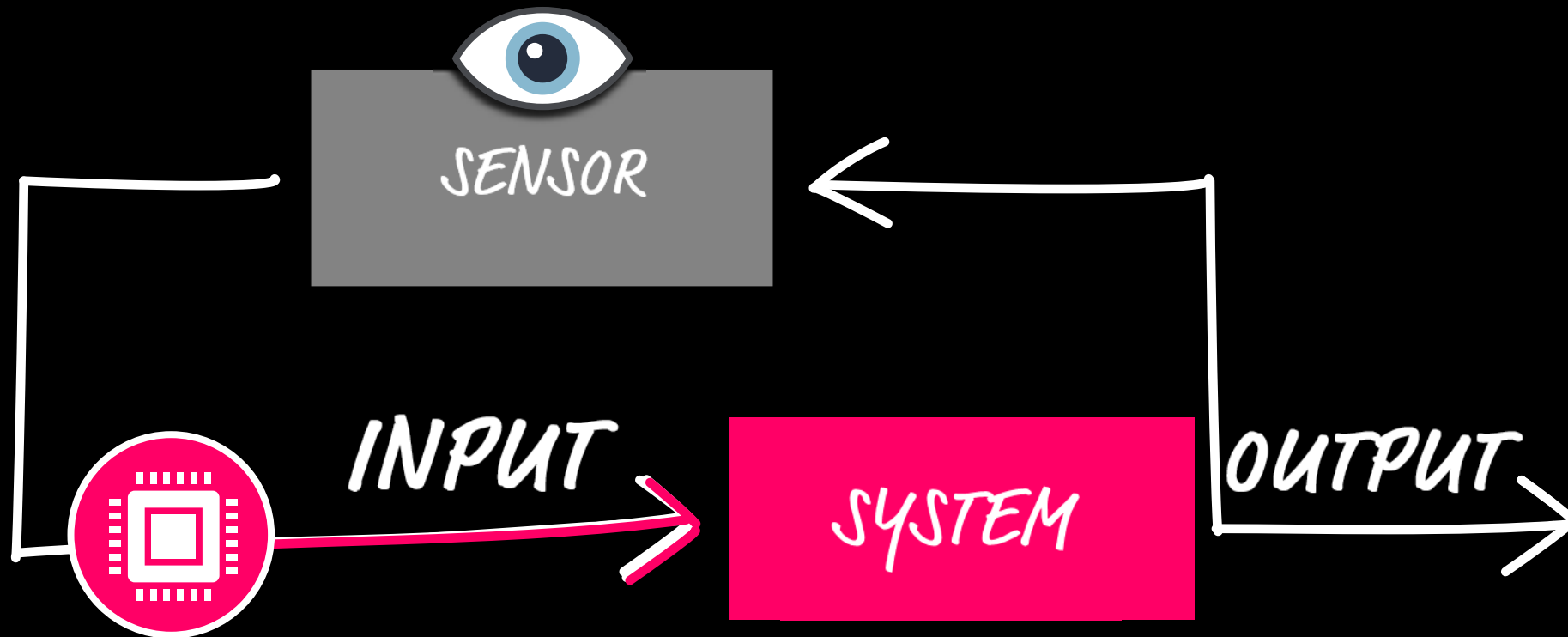
learning engineering ['lɜːniŋg ,enjə'niriŋg]

Learning engineering is a **process** and practice that applies the...

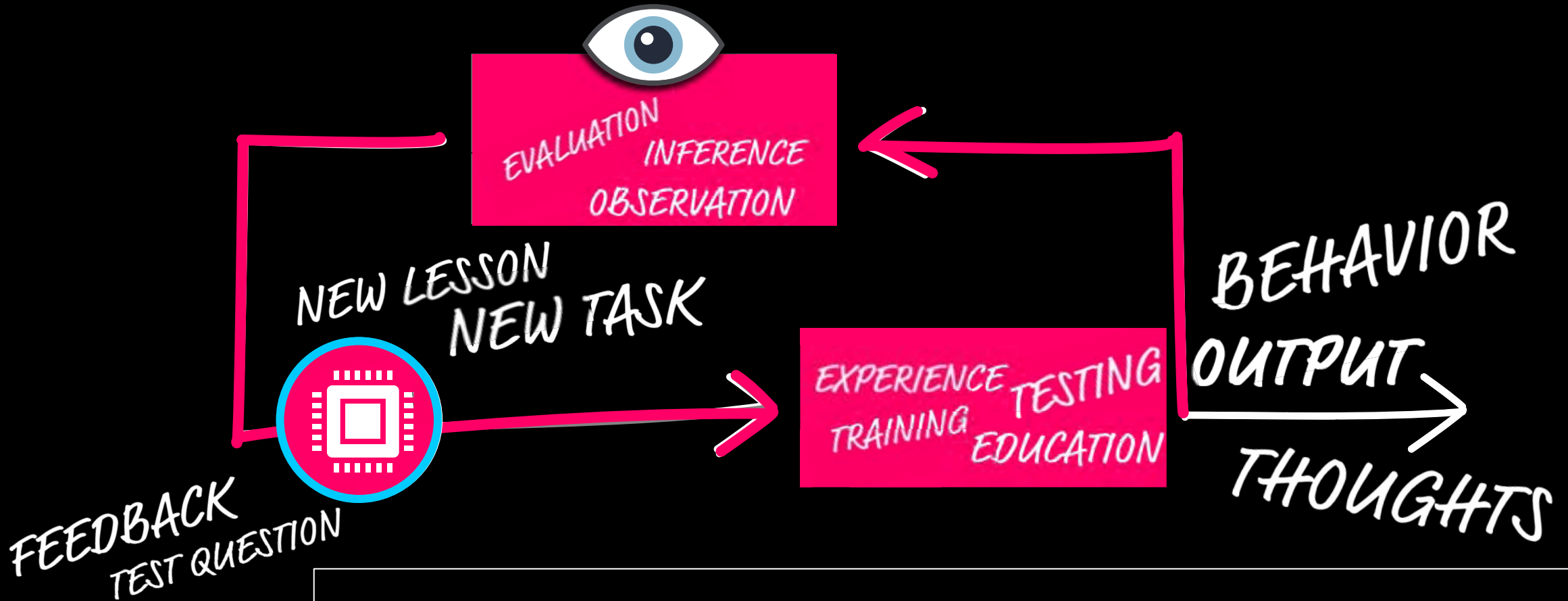
AN ITERATIVE



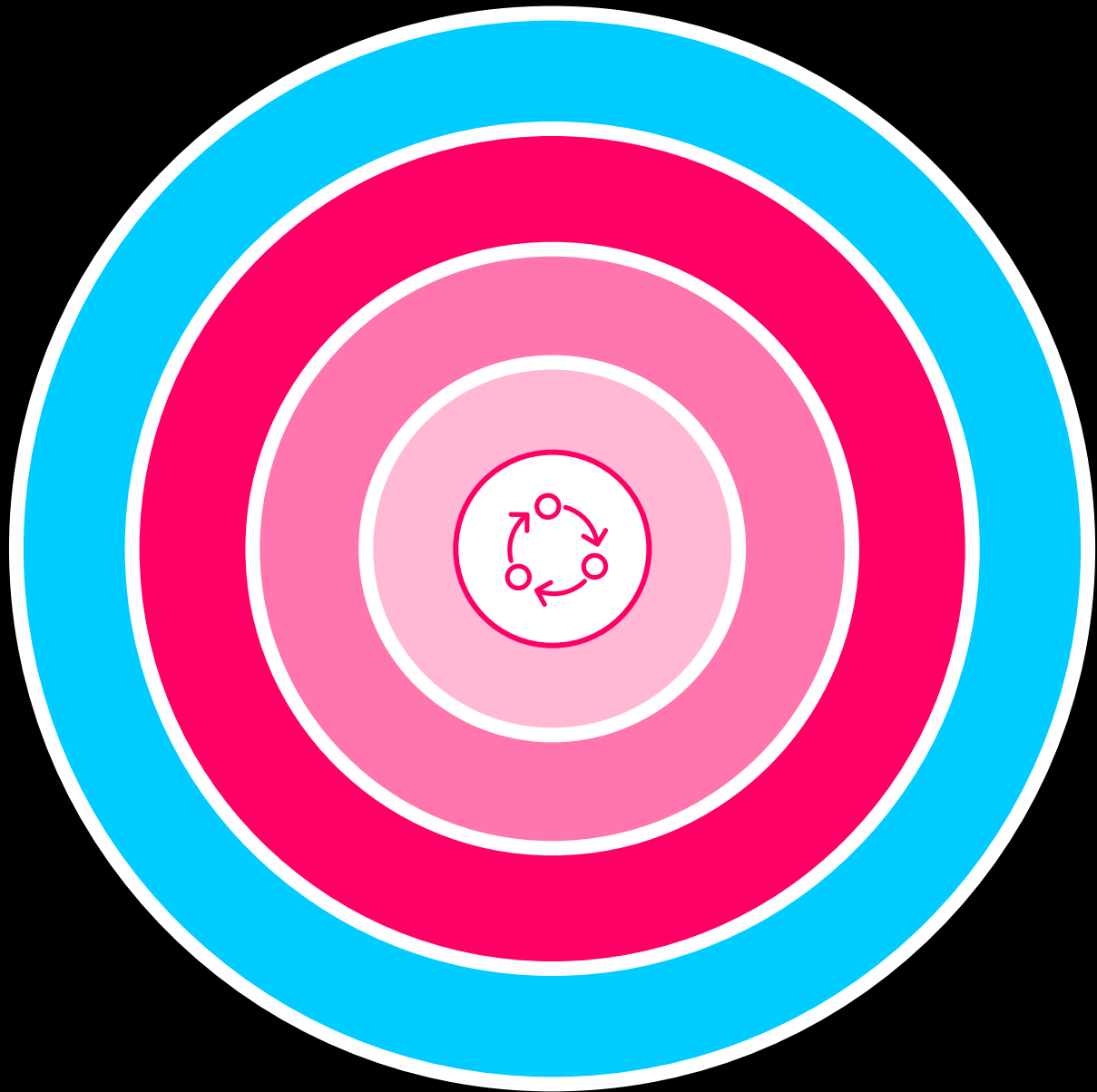
A process is a series of actions or steps taken to achieve a particular end. A process has: inputs, process steps, and outputs.



An iterative process uses feedback loops to continuously inform and improve the output.



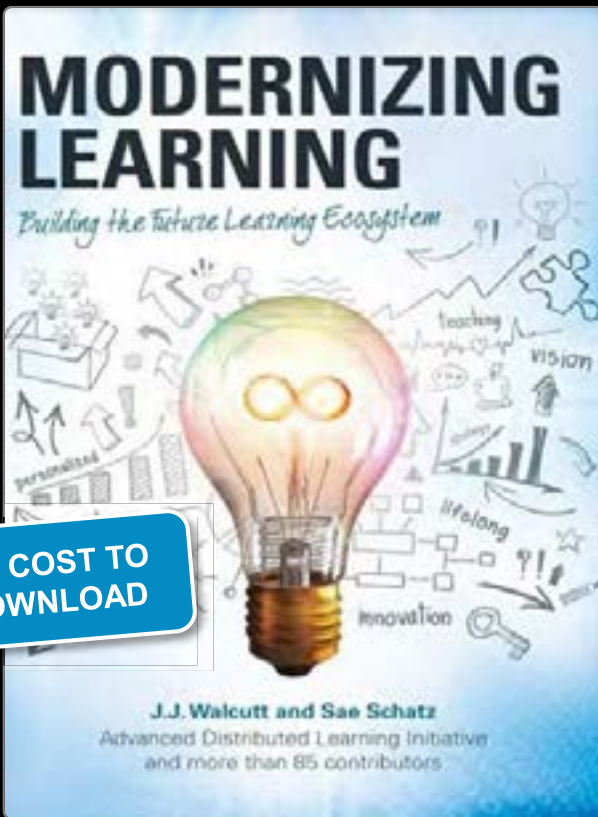
In a learning, development, and performance context, the “system” may be education, training, testing, and so on; the “observation” may be simple behavioral documentation, evaluation, inference, and so on; and the “control” (inputs after the feedback loop) may be a new lesson, feedback, a different test, et cetera.



These feedback loops can be applied within an immediate, local “micro” context, such as within a single exercise or adaptive test.

They can also apply at a more macro context, such as within a single course—and beyond. You can imagine a series of nested feedback loops surrounding a lifelong learner, with each potentially optimized through learning engineering processes: from the problem level, to the course level, to the credential level, up to the career/lifelong levels of abstraction.

The data collected during these loops can also inform feedback on the process itself, helping to drive continuous improvement of learning, development, testing, and assessment—so that they collectively become an integrated continuous service rather than a series of standalone products.



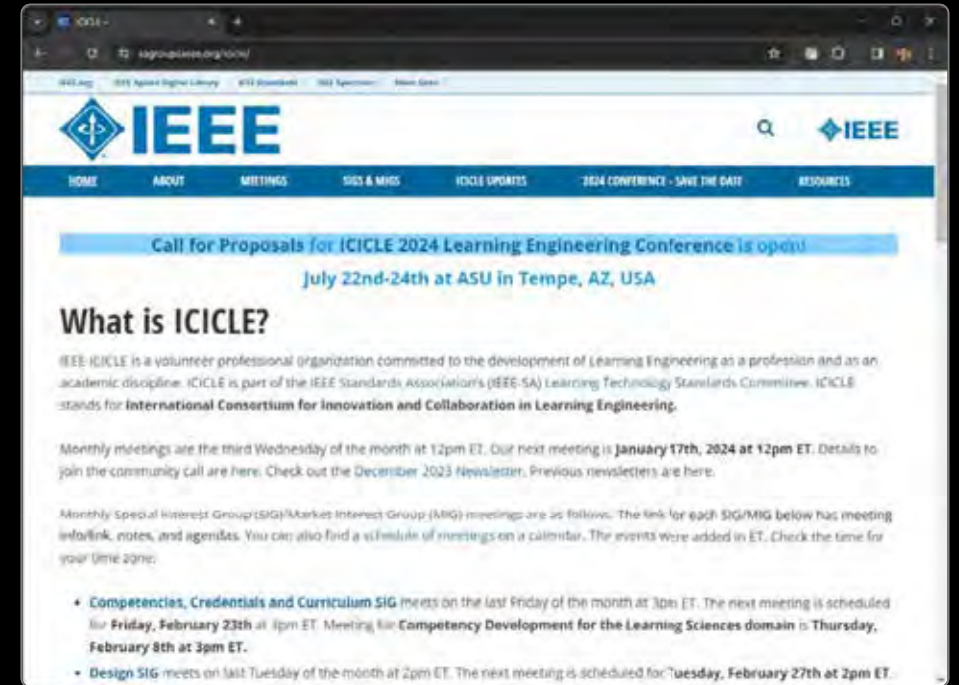
Walcutt, J. J. & Schatz, S. (Eds.). (2019). *Modernizing learning: Building the future learning ecosystem*. Washington, DC: Government Publishing Office.

<https://adlnet.gov/publications/2019/04/modernizing-learning>




Goodell, J., et al. (Eds.). (2023). *Learning engineering toolkit: Evidence-based practices from the learning sciences, instructional design, and beyond*. New York, NY: Routledge.

<https://www.routledge.com>



International Consortium for Innovation and Collaboration in Learning Engineering (ICICLE). Community of practice around learning engineering, hosted by the IEEE.

<https://ieeicicle.org>



Wait!
Why is this
ENGINEERING
???

Why is this new discipline called Learning *Engineering*? Why isn't it considered an extension of the existing field of Learning *Science*?

For that answer, consider this anecdote, taken from the *Learning Engineering Toolkit*...

In 1928, Alexander Fleming discovered penicillin but couldn't produce the drug at scale. By June 1942, US labs had only enough to treat about ten patients. The urgency of lives being lost in the war meant that production of penicillin needed to move out of the laboratory and into mass-production. This was no longer just a scientific endeavor; it required engineering.

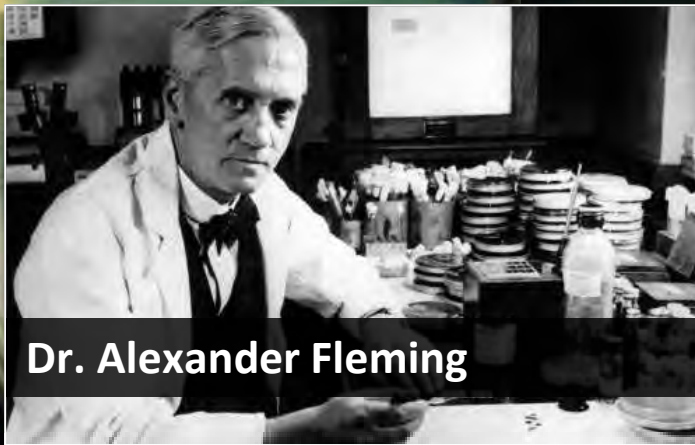
Engineers Begin to Scale



First Factory Opens

WWII

1928



Dr. Alexander Fleming

1939

1941

1944

Science

The goal of science is to discover the truth about the world as it is

Dr. Alexander Fleming

1928

Engineers Begin to Scale

Engineering

The goal of engineering is to create scalable solutions to problems using science as one tool in that endeavor

First Factory Opens

WWII

1939

1941

1944



...and isn't this what we're all trying to do: Create scalable solutions using science and other disciplined processes? So that we can keep pace with our evolving work, developing the breadth and sophistication of knowledge and skills needed for our complex world, and so that we can overcome the modern Fog of War.



create scalable solutions to problems using science as one tool in that endeavor



How does AI support military Education, Training, Exercises and Evaluation

This white paper was developed by the PPEC ADE WG as part of its "ETEE Education Capabilities Quick-Look" series to inform next-generation Education, Training, Exercises, and Evaluation among military partners.

This white paper is intended to give military leaders involved with learning and education (e.g., commanders, deans, department directors, faculty, and staff) a quick and pragmatic overview of AI within the context of military learning and development. It is a 9-minute read.

What is AI and how can it support military ETEE?

Artificial Intelligence (AI) is a broad class of software that performs human-like functions such as problem-solving, predicting, and learning. AI that "learns" is called **Machine Learning (ML)**. Today, when most people refer to "AI," they are really talking about ML. Specifically, ML is a subset of AI that develops its functionality by looking for patterns in data. For example, an ML algorithm can "learn" to predict which students are most likely to need help in class by looking at historical data on the characteristics of successful and unsuccessful students. To "train" an AI algorithm, it needs to analyze thousands (or millions or billions) of real-world examples. Then it can look for probabilistic correlations from the data set.

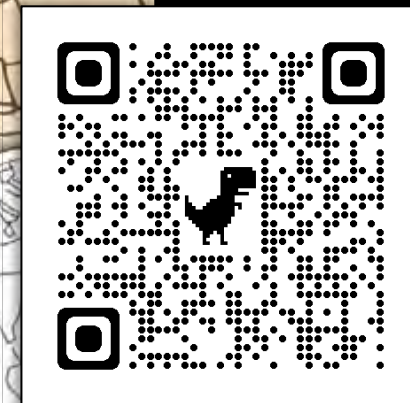
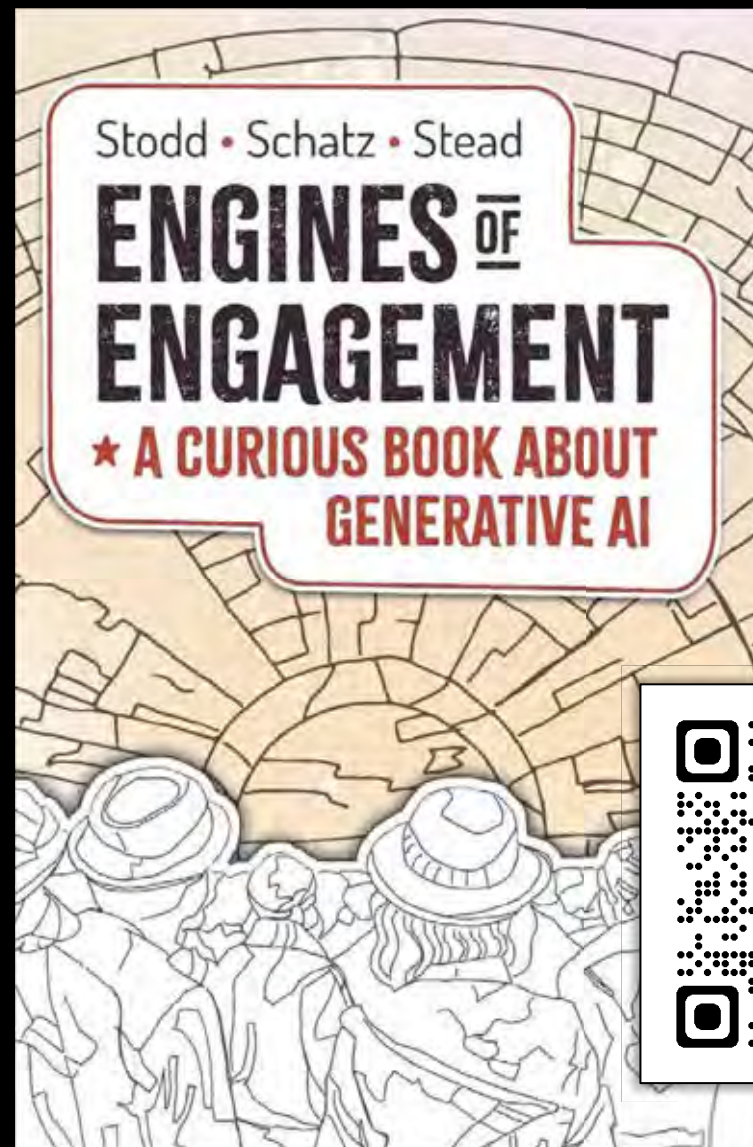
More recently, a subset of ML called **Deep Learning** has been unveiled. Unlike shallow ML, which requires carefully labeled ("supervised") data, Deep Learning can find patterns in complex, unstructured data, such as images, videos, books, geographical data, and more. When trained on a very large set of data, such as books and pictures, a Deep Learning algorithm can learn to create derivatives of those texts and images. These algorithms are called **Generative AI**. It is the underlying technology behind popular tools like ChatGPT (text) and DALL-E (images).

AI can support many different Education, Training, Exercises and Evaluation (ETEE) activities. It can be used across the ETEE lifecycle to support learning content design and development, delivery, management, and evaluation. AI tools can also support diverse stakeholders, including trainers and students, faculty and staff, and organizations. The professional discipline of using AI, data, and human-centered engineering approaches in conjunction with learning science is referred to as "**Learning Engineering**."

What are some common mistakes (risks) made around AI for ETEE?

(1) Waiting until your program is "ready" for AI (at some future date)

The (digital) world is changing rapidly, and AI tools are growing more numerous each day. If ETEE leaders do not invest in AI pilot projects now, then their personnel will fall behind and struggle to catch up in the future. Although any new technology comes with challenges and risks, do not let that complexity create a state of paralysis. Find a way to say "yes" to AI pilot projects, and do so



<https://www.pfp-consortium.org/media/489/download>

<https://bit.ly/EnginesOfEngagement>