THE AUTOMATED WORLD
A COMBINATORIAL FORECASTING TOOLKIT

We're on the verge of entering an automated world where everyday people, organizations, and cities use previously unimagined machine power, where algorithms make art and diagnose illness, and where humans+machines redefine how we live, work, and play. In this future, billions of things in our material world get networked and take on unprecedented capabilities. They'll have **on-demand intelligence** and be capable of **continuous capture and sensemaking** and **simulating complex decisions**. And they won't be static but instead adapt as **evolvable hardware** and contain **encoded judgments** that shape the outcomes of their actions. The technologies of the automated world will be available to everyone. How will you use them?
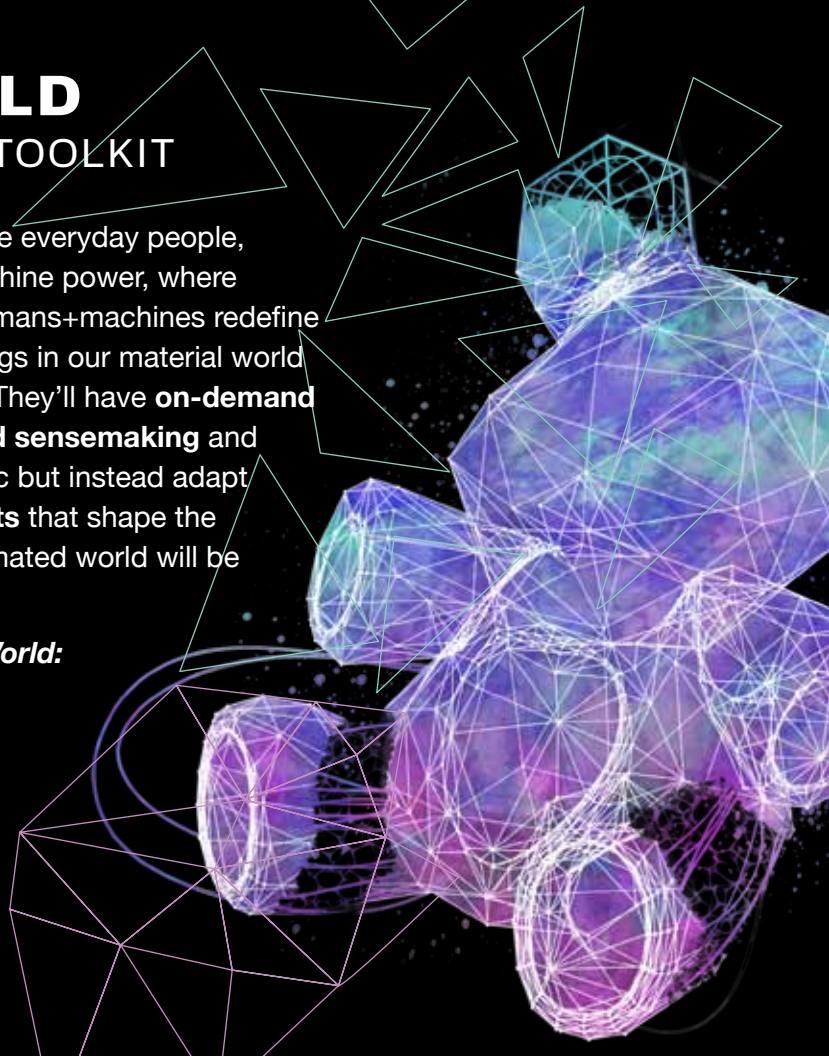
This toolkit, with its companion map, *The Automated World: Toward Human+Machine Symbiosis,* is your guide to navigating the coming decade.

the
automated
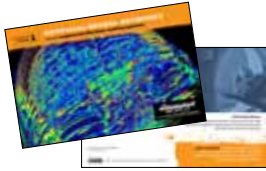## WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

INSTITUTE FOR THE FUTURE

HOW TO USE

This toolkit contains several suits of cards to help you create your own forecasts, explore the future at the intersections of foundational technologies, generate strategic insights, and begin prototyping the future you want today.

Step
▸1

BUILD YOUR
COMBINATORIAL FORECASTS

This suit of 18 cards describes the different Foundational Technologies that combine to make the automated world possible. Use them to create your own combinatorial forecasts of the new automated world.

Step
▸2

CHART YOUR
FUTURE POSSIBILITIES

This suit of 5 cards outlines the combinatorial forecasts that are the building blocks of the automated world. Use these cards to think through their impact and generate strategic insights.

Step
▸3

DESIGN YOUR
ARTIFACTS FROM THE FUTURE

This suit of 6 Artifact from the Future cards describes scenarios of products, services, and systems of the automated world. Use them to tell your own story of the automated world and design your own artifact from the future.

BUILD YOUR
COMBINATORIAL FORECASTS

To understand the promise and power of the automated world, we must understand the basic technology foundation.

This suit of 18 cards describes the different foundational technologies that combine to make the automated world possible. Each is a force in its own right, but in combination they open up totally unprecedented possibilities.
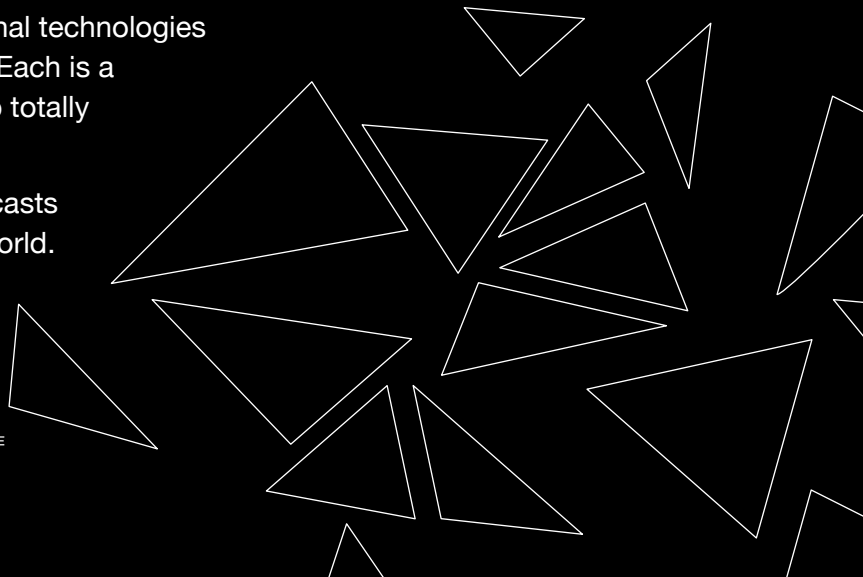
In this step, you'll create your own combinatorial forecasts of new capabilities we'll use to build the automated world.

the automated WORLD
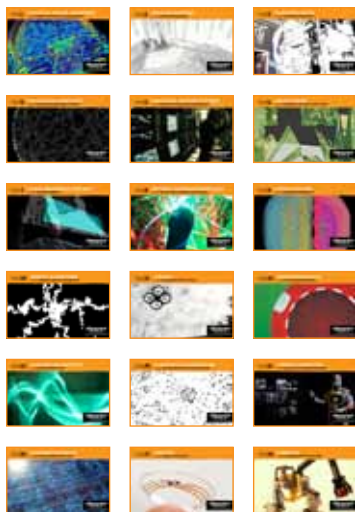
TOWARD **HUMAN+MACHINE** SYMBIOSIS

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BUILD YOUR COMBINATORIAL FORECASTS
instructions

Get familiar with foundational technologies by laying out all 18 cards and reading them out loud.

▶▶

Explore powerful combinations by considering different clusters of at least three cards and looking for combinations that will have the most impact on your future.

▶▶

Build your own combinatorial forecast by selecting the most impactful combination, giving it a title, and forecasting how they combine to create a transformative future.
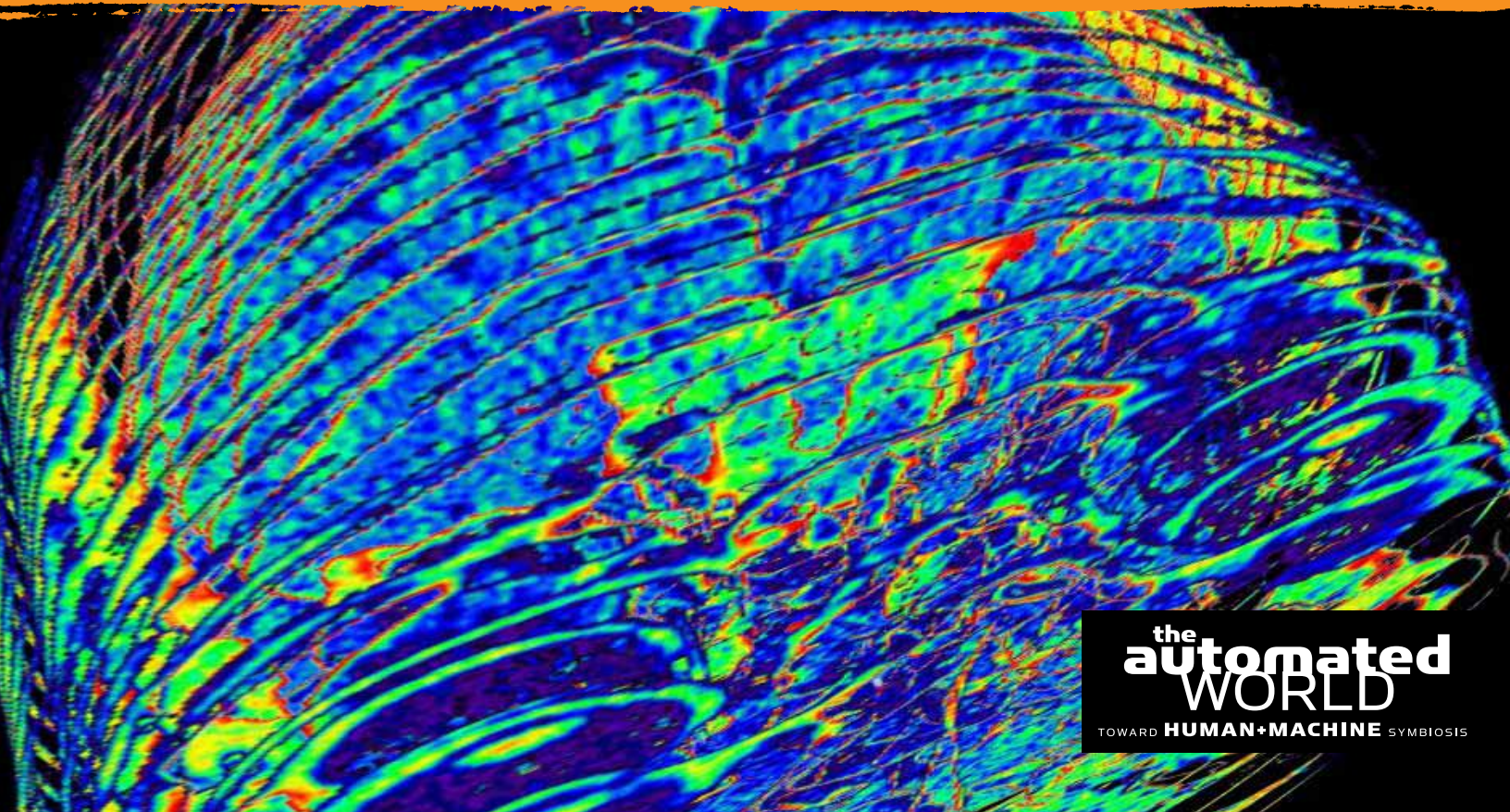
ARTIFICIAL NEURAL NETWORKS
toward **augmented decision-making systems**

the **automated** WORLD

TOWARD **HUMAN+MACHINE** SYMBIOSIS

ARTIFICIAL NEURAL NETWORKS
toward augmented decision-making systems

Artificial neural networks are statistical computing models inspired by biological networks, such as ecological systems and the brain. They're used to understand relationships in data and provide a framework for computers to learn and automate decision-making. Key to computer vision and voice recognition systems, artificial neural networks allow algorithms to create models of the world through data and become more "intelligent."

Anticipating illness
Nervana augmented decision-making systems can help machines anticipate an illness before it becomes terminal and help technology interact with humans.

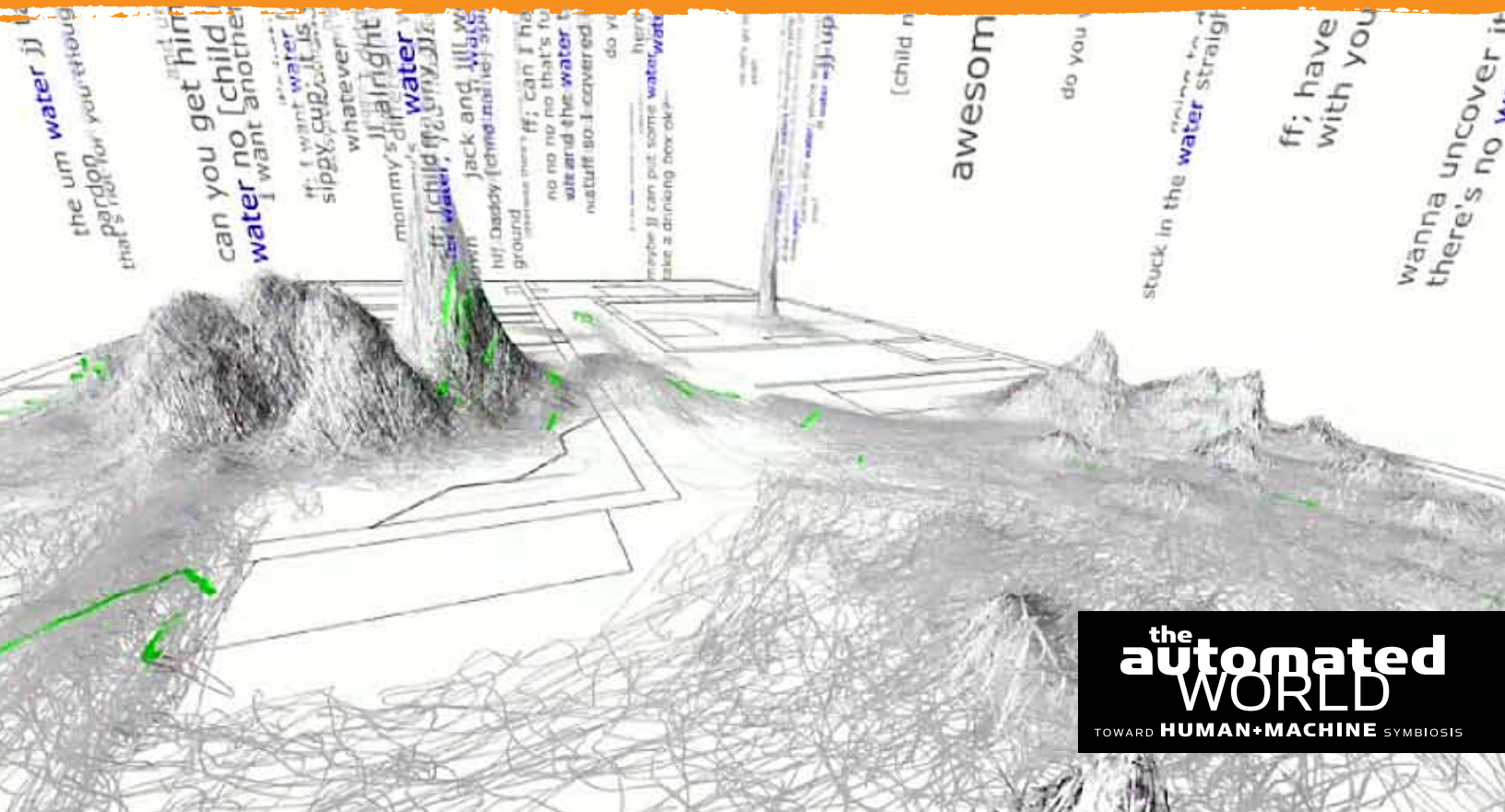Front: Wikipedia user Dale Mahalko
Back: nervanasys.com

WHAT TO EXPECT: Computational systems will draw precise conclusions using correlations within large amounts of data, as with personal assistants like Siri or investment tools for financial analysts.

MACHINE LEARNING
toward **anticipatory systems**

the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

Machine learning, a branch of AI, relies heavily on probability statistics to make inferences. This enables machines to predict outcomes, make decisions, and automate operational processes. Applied across a wide spectrum of domains—from monitoring credit card fraud to calculating the best move in a chess game—machine learning will continue to advance into commercial applications, ultimately emulating human cognitive capabilities for even sophisticated, nuanced tasks.

Machines learn to forecast

Skytree develops machine-learning algorithms that predict the likelihood of default on a loan or the probability of acts of terror.

WHAT TO EXPECT: As machines gather more data across touchpoints, they learn continuously. Algorithms will outperform humans in highly complex cognitive tasks such as forecasting market volatility.

Front: Flickr user: Marius B
Back: skytree.net

the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

COMPUTER VISION
toward computable visual data

Visual information is becoming computable data that can be analyzed—enabling machines to make sense of visual information and in effect "see." Deployed in surveillance, factory settings, and even entertainment—in the form of tools such as Microsoft's Kinect—computer vision is enabling machines to interact with the physical world in more sophisticated ways.

Automated quality control
Sight Machine captures and analyzes data from cameras, sensors, and automation systems to deliver insights that help manufacturers control quality.

Front: Flickr User: Kyle McDonald
Back: sightmachine.com

WHAT TO EXPECT: We'll see computer vision continue to drive increasingly precise facial recognition and be further adopted in fields such as medical diagnostics and home security.

the automated
WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

Foundational Technology 4

DISTRIBUTED COMPUTING
toward cloud supercomputing on demand

In distributed computing, processing functions are performed across two or more physically separated devices. A process can be used to parse datasets, allowing each to be analyzed individually and scaled across thousands of distributed machines. Distributed computing is critical to successfully making sense of big data and will enable cloud supercomputers to be accessible on demand.

Plummeting genetic sequencing costs
uBiome is one of multiple DNA sequencing companies using distributed computing to significantly lower the cost of genetic sequencing.

WHAT TO EXPECT: With the exponential growth of mobile devices and continuation of Moore's Law, distributed computing will enable everyday smart objects to access and interact with us.

INDUSTRIAL CONTROL SYSTEMS
toward **networked and synchronized systems**

the automated WORLD

TOWARD **HUMAN+MACHINE** SYMBIOSIS

INDUSTRIAL CONTROL SYSTEMS
toward networked and synchronized systems

Industrial control systems, such as HVAC and logic controller systems, are computer-based systems that monitor and control industrial processes in the real world—particularly complex, heavy industry fields. They're critical for managing everything from energy grids to assembly lines. Industrial control systems are increasingly being built into homes and cars to enable remote and phone control over appliances and systems such as heating.

Adaptable infrastructure management

Lagoon makes water management more adaptable and intelligent by integrating sensitive sensors and algorithms to monitor usage and predict leaks.

Front: U.S. Navy photo by Journalist 1st Class James Pinsky
Back: golagoon.com

WHAT TO EXPECT: Sensors and algorithms integrated into industrial control systems will produce finer granularity about the performance and efficiency of critical infrastructures ranging from energy use to manufacturing.

GRAPH THEORY
toward **machines as the new creative class**

the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

GRAPH THEORY
toward machines as the new creative class

Graph theory is a branch of mathematics concerned with how networks can be encoded and measured to combine multiple variables to create new findings. It's used in complex applications such as enhancing drug discovery and measuring the probability of effective medical treatment, as well as developing new food recipes—bringing machines into creative tasks we once believed only humans could perform.

COGNITIVE
C C
COOKING

Machine-intelligent culinary arts
IBM's Chef Watson uses graph theory to algorithmically combine ingredients, creating dishes from classic to, ostensibly, strange bases.

Front: Flickr User: Karl-Ludwig Poggemann
Back: ibm.com

WHAT TO EXPECT: Ever-growing data sources, increased computational capacity, and surging market demand for data analytics will drive organizations to discover new trends, insights, and products.

the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

HUMAN-MACHINE INTERFACES
toward enchanted objects

Perhaps one of the most underappreciated ways we interact with the automated world is through human-machine interfaces—or user interfaces—connecting us to our digital information devices. Well-designed interfaces enable us to easily control or collaborate with machines, whether we're interacting seamlessly with a smart phone or operating an appliance at home.

Programmable self-control

The iBag uses an Arduino chip to lock itself when or where its wearer is most vulnerable to overspending.

Front: Flick User: Atsushi Tadokoro
Back: yahoo.com

WHAT TO EXPECT: Connected to the Internet of Things, interfaces will respond intuitively and adapt to our movements, words, facial expressions, and needs.

NATURAL LANGUAGE PROCESSING
toward **casual communication with machines**

the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

NATURAL LANGUAGE PROCESSING
toward casual communication with machines

Natural language processing is the ability of a computer program to understand casual human language. As used by social networks and advertisers, natural language processing enables algorithms—and some robotic systems—to derive meaning from speech and interact with humans in a more fluid, seamless way.
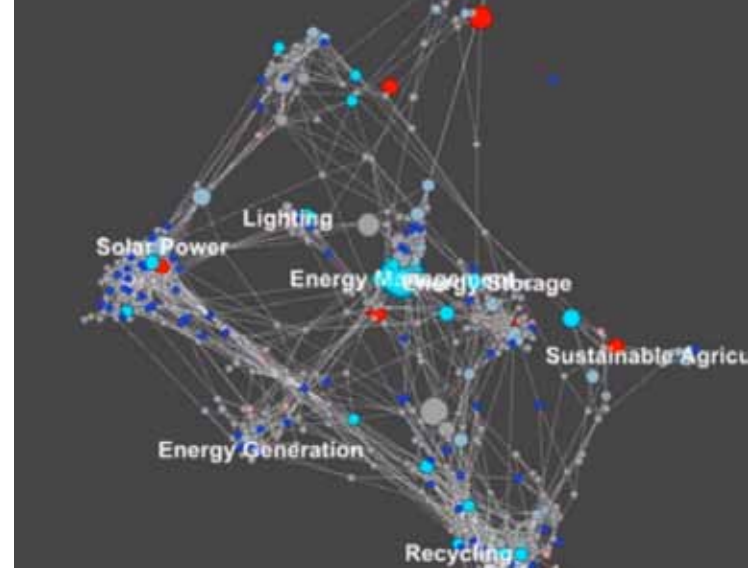
Discovering opportunities

Quid analyzes investment data, news feeds, patent data, academic journals, and social media streams to identify trends and opportunities.

Front: Flick User: Rob Walker
Back: quid.com

WHAT TO EXPECT: Computers will read and understand human language as easily as humans do, driving the creation of real-time, machine-enabled translation services from language to language.

EXPERT SYSTEMS
toward **augmented intelligence**
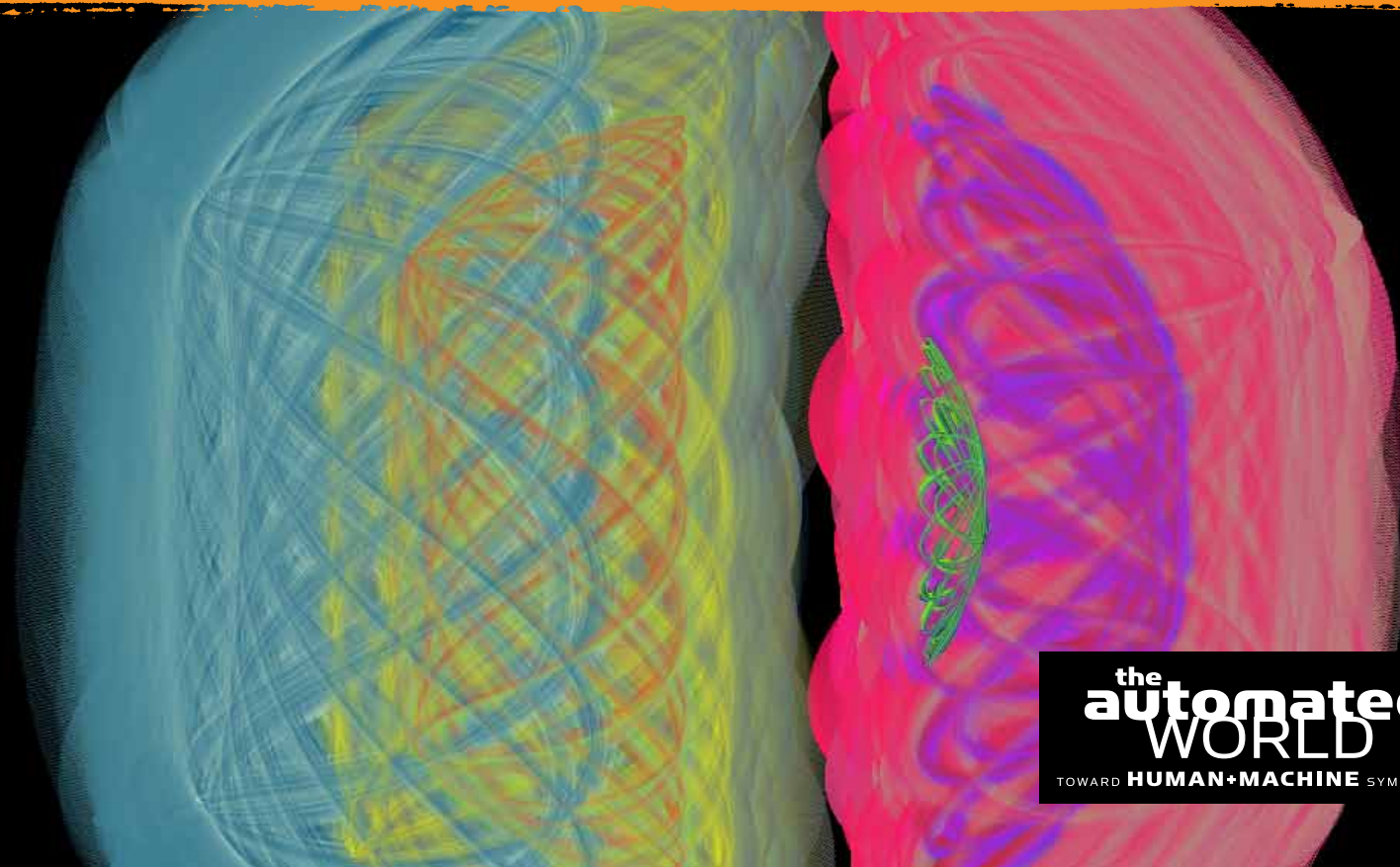
the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

EXPERT SYSTEMS
toward augmented intelligence

Expert systems facilitate problem solving by drawing inferences from a knowledge base developed from human experience. They can simulate expert perspectives and automate systems in ways that can mimic and outperform even the sharpest human minds in a field.

Algorithm on board of directors

Deep Mind Ventures appointed an algorithm as a member of its board of directors, enabling it to vote on investing decisions.

WHAT TO EXPECT: Expert systems will increasingly augment— and at times replace—human decision-makers in fields such as investing and medical prognosis that benefit from large-scale variable analysis.

GENETIC ALGORITHMS
toward **adaptive systems management**

the
automated
WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS
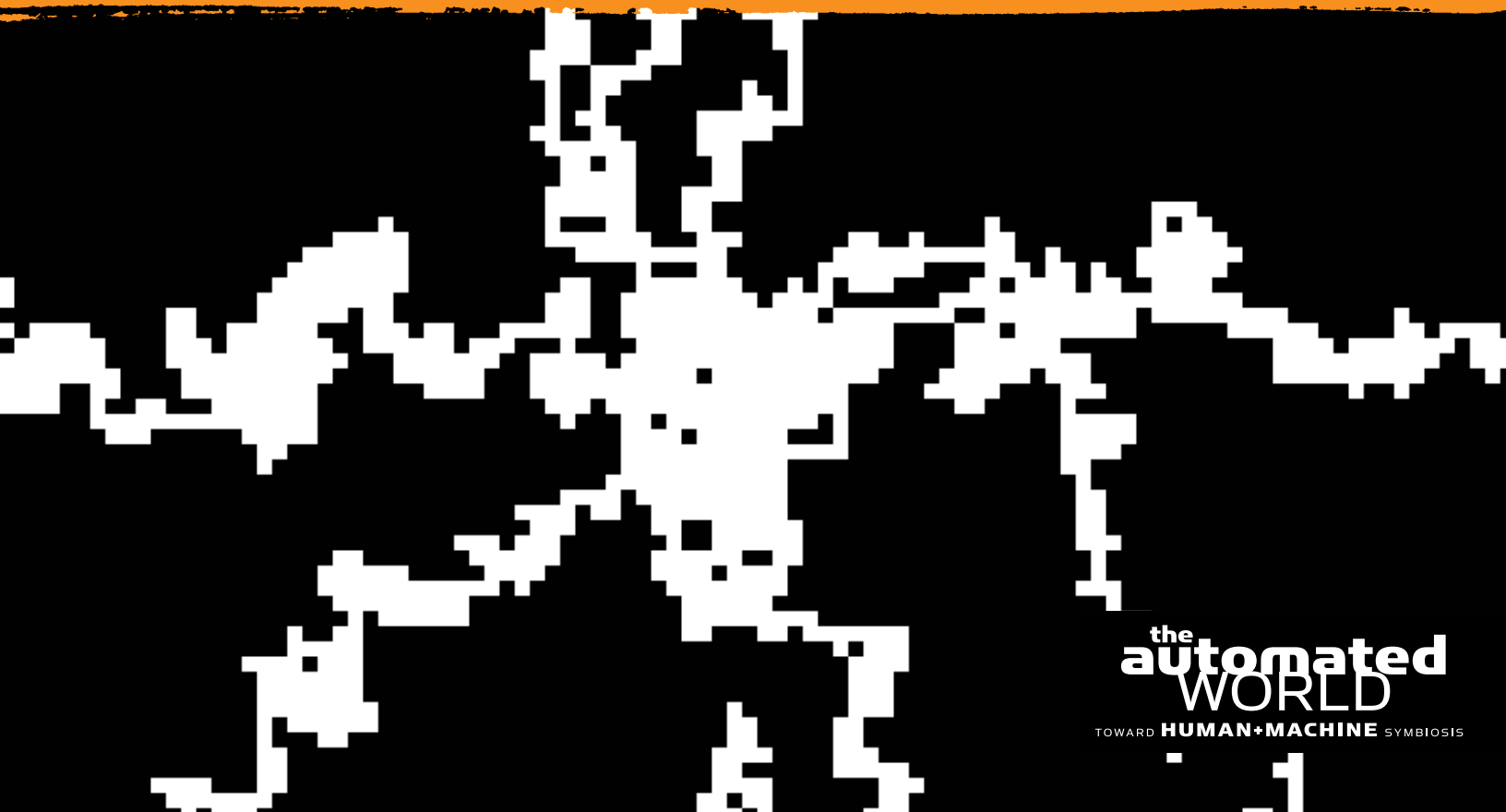
GENETIC ALGORITHMS
toward adaptive systems management

Genetic algorithms are adaptive, heuristic search algorithms that mimic natural selection for discovery. They can efficiently route supply chains, allocate international equity strategies, and even create new medicines, based on mutations in viruses that may not be immediately obvious to human researchers.

Precisely programming subway maintenance

Hong Kong's subway uses a genetic algorithm–based system to schedule projects in one of the most efficient maintenance systems.

Front: Flickr User: Ken
Back: newscientist.com

WHAT TO EXPECT: Genetic algorithms will help manage the flow of people, goods, and information, particularly when the underlying variables or issues being managed can change unpredictably.

DRONES
toward **unmanned matter routing**

DRONES
toward unmanned matter routing

Drones, or unmanned systems, are using robotics for many types of delivery, surveillance, and logistics. Although regulatory markets surrounding the technology are still evolving, as prices plummet, this rapidly changing technology is already gaining traction and being explored in uses ranging from product routing and distribution at Amazon and UPS to smuggling drugs into prisons to military and environmental surveillance.

Drone-delivered mail
The Swiss postal service has announced a partnership with the drone company Matternet to test drone-powered mail delivery.

WHAT TO EXPECT: The democratization of drones as a commercial enterprise will bring ever more sophisticated unmanned systems, from pilotless logistics fleets to on-demand aerial systems.

Front: Flickr User: John Mills
Back: slate.com/blogs/future

INFERENCE ENGINES
toward simulating possibilities

Within an expert system, inference engines are the components that use reasoning principles and procedures to draw conclusions based on information stored in a knowledge base. They're used within graphs, artificial neural networks, and big data to infer the likelihood of specific event outcomes and make recommendations to human users by simulating outcomes of different possibilities.
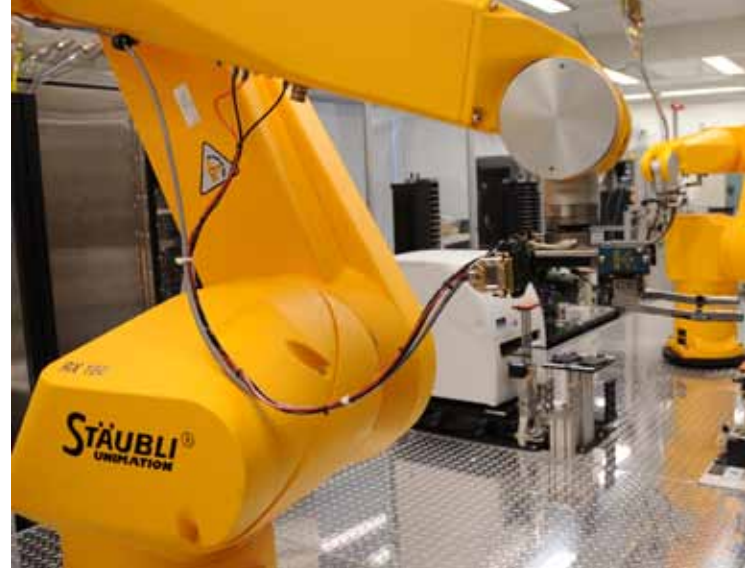
Novel drug targeting

GNS Healthcare and CHDI Foundation use inference engines to process data to find new molecular targets for treating Huntington's Disease.

Front: Flick User: General Physics Laboratory (GPL)
Back: chdifoundation.org

WHAT TO EXPECT: Inference engines will continue to drive and expand efforts to simulate promising outcomes—ranging from product concepts to service opportunities—by analyzing complex, interoperable datasets.

AUDITORY RECOGNITION
toward acoustic awareness

Auditory recognition systems use advances in microphone technologies, speech recognition algorithms, and noise-cancelling technologies to ascertain specific sounds within environments. Such advances help computers identify what sounds are being emitted within a given environment and what actions should be triggered as a result of specific noises, such as a breaking window or a baby's cry.
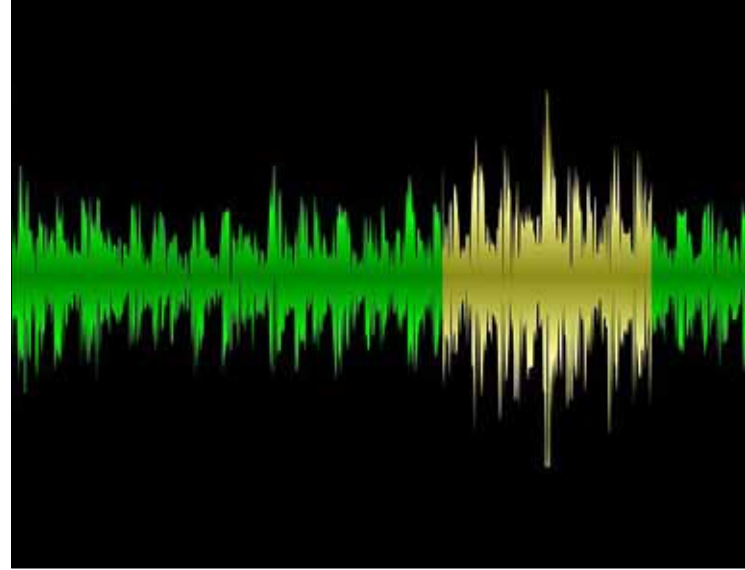
Auditory recognition devices
Listnr can analyze sounds and respond by sending notifications or triggering automated actions, such as turning lights on or off.

Front: Flick User: mikael altemark
Back: kickstarter.com/projects

WHAT TO EXPECT: Auditory recognition systems will be further connected to the Internet of Things and automatically be integrated into security and entertainment systems.

BLOCKCHAIN TECHNOLOGIES
toward **a decentralized transaction network**

BLOCKCHAIN TECHNOLOGIES
toward a decentralized transaction network

Blockchain technologies create distributed, publicly accessible ledgers of transactions, allowing financial, identity-based, and other kinds of transactions to take place securely without third-party intermediaries. Because blockchains are both transaction- and software-oriented, programs and tools can be developed on top of them that enable transactions to occur automatically, allowing individuals or devices to connect and communicate without additional brokers regulating the exchange.

Autonomous contracting and commerce

IBM and Samsung partnered on using blockchains to enable objects to conduct commerce, such as a washing machine reordering detergent.

Front: Flickr User: Simon Cockell
Back: coindesk.com/ibm

WHAT TO EXPECT: Blockchains will enable autonomous commerce between individuals, institutions, and devices, decreasing the ability of governing intermediaries to control how such exchanges may occur.

the automated
WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

AMBIENT COMPUTING
toward pervasive, constant computing

As the term ambient suggests, this computing power is virtually everywhere and always on. Driven in part by the rise of the Internet of Things, a trillion-node network will mediate our every move. Unlike the Internet, however, this network won't be something we log into and use but something we live within, whether we're at the grocery store or on the couch watching TV.

Devices always listening

Amazon's Echo, which is activated by a keyword, takes voice commands to do everything from creating lists to ordering products.

Front: Flickr User: Keoni Cabral
Back: fastcodesign.com

WHAT TO EXPECT: As even mundane objects come to have integrated sensors and computational abilities, environments will adapt to our actions, even if we aren't aware of being observed.

DISTRIBUTED ENERGY
toward **a decentralized power grid**

DISTRIBUTED ENERGY
toward a decentralized power grid

Distributed energy—decentralized technologies that generate smaller amounts of power per unit—increases the modularity of energy grids, encouraging life and commerce in uncommon places. With the rise of microgrid technologies that can power rural homes and offices as well as breakthroughs in battery technology, electrical power is becoming cheaper, more sustainable, and easier to access in extreme environments.

Off-the-grid home power

Tesla's Powerwall Home Battery helps consumers power buildings without the need for the power grid—promising to store more energy than most homes consume on a daily basis.

WHAT TO EXPECT: Battery technology will power smaller devices for longer, in more extreme environments, and more economically. Breakthroughs in mobile sensors will revolutionize the power grid.

Front: Flickr User: Takver
Back: teslamotors.com/powerwall
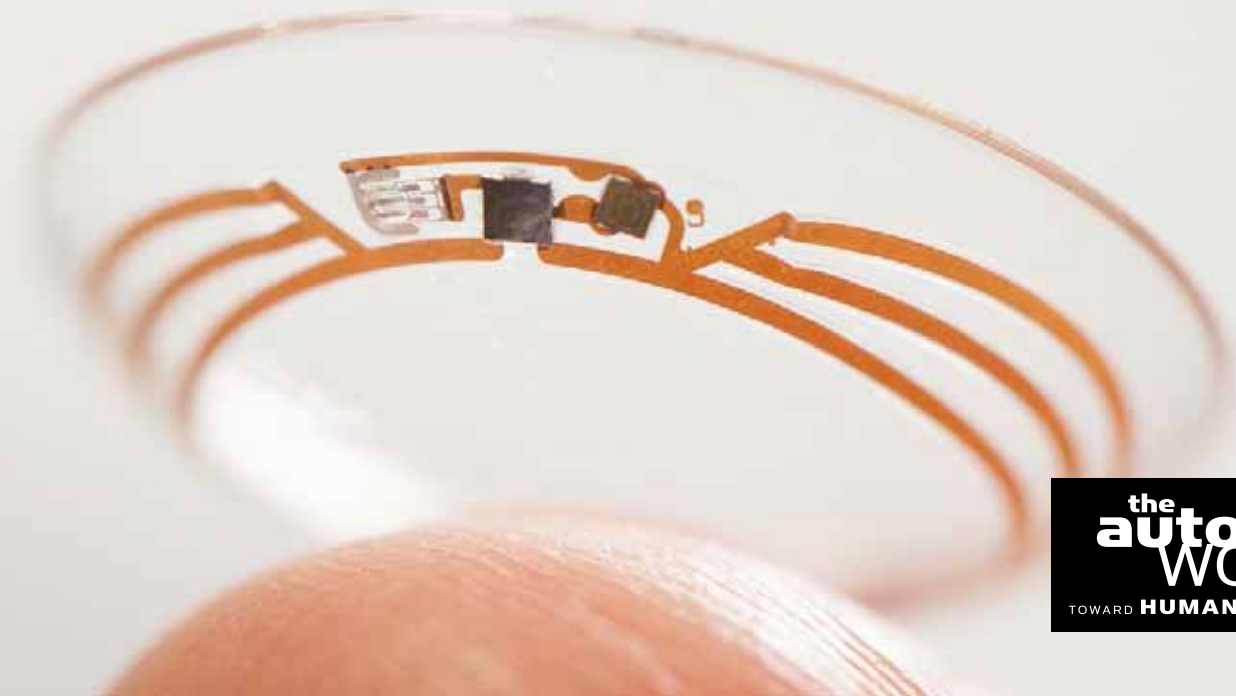
SENSORS
toward context-awareness

Sensors enable real-time monitoring of critical infrastructure, control systems, and behaviors even at a personal level. They can use a variety of methods—light, sound, temperature, and pressure—to measure the world around them. Sensors monitor the physical world and connect into the digital world, layering analytics tools and algorithms to track and predict how the environment will change.

Operations measured in extreme locations

To anticipate oil well repairs, Halliburton uses sensors and fluid-analysis tools that measure gas concentrations at pressures up to 20,000 psi.

Front: Google Inc.
Back: laserfocusworld.com

WHAT TO EXPECT: Sensors will be embedded in devices and integrated into even the most mundane locations, for purposes ranging from surveillance, advertising, and security to personal fitness.

ROBOTICS
toward **machine driven productivity**

the au**to**mated
WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

ROBOTICS
toward machine driven productivity

Robotic systems, long in use on factory floors, are gaining increasingly sophisticated and fine-grained controls that improve performance in manufacturing, assembly, and human-machine interactions. Already found in homes and cars, robotic systems are being adopted more and more widely in settings as diverse as emergency rooms, warehouses, and caregiving facilities.

Bot with superhuman strength
Seegrid's GP8, a vision-guided forklift designed to transport pallets in warehouse settings, carries up to 8,000 pounds and learns 25 miles of driving routes.

Front: Flickr User: The Magic Tuba Pixie
Back: seegrid.com

WHAT TO EXPECT: Robotic systems will become increasingly accessible and commonplace in industrial environments, used in tasks for everything from moving freight to manufacturing pharmaceuticals.

CHART YOUR
FUTURE POSSIBILITIES

Combinatorial Forecasts represent the **building blocks** of the automated world. What will you build with them?

This suit of 5 "Combinatorial Forecast" cards describe forecasts of emerging capabilities that different combinations of Foundational Technologies generate. Use these cards to consider the disruptive impact and transformational possibilities of the automated world.

In this step, you'll chart strategic insights across several impact areas.

the
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WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

INSTITUTE FOR THE FUTURE
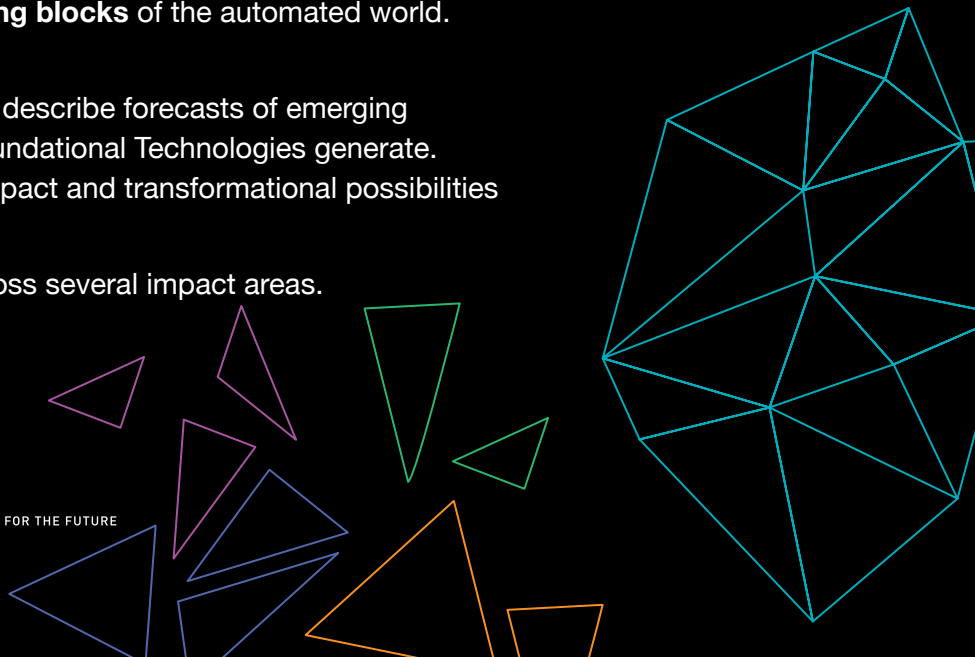
STEP ▸2

CHART YOUR FUTURE POSSIBILITIES
instructions

Review five Combinatorial Forecast cards to learn about the building blocks of the automated world. Then:

① **Add your own Combinatorial Forecast** from the last step here

② **Generate Impact Zones** that are important to you or your organization and add them here

③ **Chart Strategic Insights** by identifying critical intersections where Combinatorial Forecasts meet your Impact Zones to create new opportunities or challenges

COMBINATORIAL FORECASTS

IMPACT ZONES	CONTINUOUS CAPTURE AND SENSEMAKING	SIMULATING COMPLEX DECISIONS	ON-DEMAND INTELLIGENCE	EVOLVABLE HARDWARE	ENCODED JUDGEMENT	_____
Human Resources	Automated Employee Wellness	Staffing with Robots	On-Demand Wellness Counseling			
Marketing	Dynamic Ads in Place		Interactive Ads			
Product Development				Future-Proof Design		
Distribution		Algorithmic supply chain management			Priority Sustainability	

Foundational Technology 1
ARTIFICIAL NEURAL NETWORKS
toward **augmented decision-making systems**

Foundational Technology 2
MACHINE LEARNING
toward **anticipatory systems**

Foundational Technology 3
COMPUTER VISION
toward **computable visual data**

Foundational Technology 8
NATURAL LANGUAGE PROCESSING
toward **casual communication with machines**

Foundational Technology 12
INFERENCE ENGINES
toward **simulating possibilities**

Foundational Technology 17
SENSORS
toward **context-awareness**

Foundational Technology 13
AUDITORY RECOGNITION
toward **acoustic awareness**

the au⊥omated
WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

CONTINUOUS CAPTURE AND SENSEMAKING
persistent data capture and analytics

As advances in sensor technologies, cameras, and storage continue, we're gaining the ability to continuously capture, mine, and recognize virtually every situation or moment. This ability to capture, summarize, and make meaning of a scene is part of the underlying architecture for self-driving cars and unmanned aerial drones, as well as a wide variety of other systems. From transforming photos into a data source for medical diagnostics to the emergence of real-time video analytics, the ability to continuously capture and analyze data is transforming how we summarize, sense and share information.

dextro.co

Computer vision algorithm aims to stop real-time video piracy

Dextro is developing a computer vision system to scan live video feeds and identify pirated or illegally streamed video in real time.

theverge.com
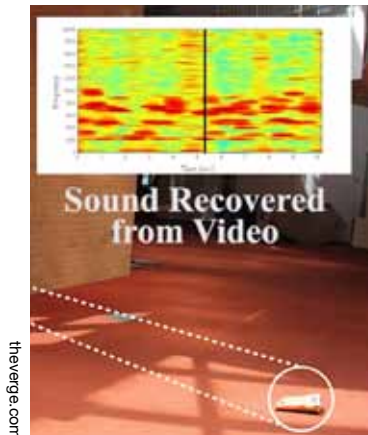
Reconstructing conversation through video feeds

Researchers from MIT, Microsoft, and Adobe reconstruct the audio of conversations using high-speed video cameras to capture vibrations against objects.

Foundational Technology 2
MACHINE LEARNING
toward **anticipatory systems**

Foundational Technology 4
DISTRIBUTED COMPUTING
toward **cloud supercomputing on demand**

Foundational Technology 1
ARTIFICIAL NEURAL NETWORKS
toward **augmented decision-making systems**

Foundational Technology 9
EXPERT SYSTEMS
toward **augmented intelligence**

Foundational Technology 10
GENETIC ALGORITHMS
toward **adaptive systems management**

the **automated** WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

SIMULATING COMPLEX DECISIONS
models to orchestrate planning, scheduling, and outcomes

Today we're using machine intelligence to simulate, model, and optimize everything from making complex decisions to identifying innovation opportunities. For instance, Hong Kong has dramatically improved the efficiency of its subway maintenance system by replacing input from multiple human experts with a machine intelligence system that simulates different possibilities to optimize the coordination of human maintenance workers. Likewise, Netflix has used increasingly complex models of viewer behavior as a means to identify opportunities for developing programming. Over time, as datasets become more robust and simulations more sophisticated, increasing numbers of small and major decisions will be optimized with the aid of simulation.

bbc.com/news

Simulation model given vote in venture capital investment decisions

Deep Knowledge Ventures appointed an algorithm, which analyzes future investment performance through simulations, as a voting member of its board.

newscientist.com

Machine-scheduled maintenance workers

Hong Kong's subway system uses a sophisticated genetic algorithm to schedule more than 10,000 maintenance workers weekly on 2,600 projects.

ON-DEMAND INTELLIGENCE
analytics at every node of the network

Foundational Technology 2 MACHINE LEARNING
toward **anticipatory systems**

Foundational Technology 17 SENSORS
toward **context-awareness**

Foundational Technology 15 AMBIENT COMPUTING
toward **pervasive, constant computing**

Foundational Technology 4 DISTRIBUTED COMPUTING
toward **cloud supercomputing on demand**

Foundational Technology 18 ROBOTICS
toward **machine driven productivity**

Foundational Technology 5 INDUSTRIAL CONTROL SYSTEMS
toward **networked and synchronized systems**

Foundational Technology 16 DISTRIBUTED ENERGY
toward **a decentralized power grid**

the **automated** WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

ON-DEMAND INTELLIGENCE
analytics at every node of the network

With the steady rise of low-energy, miniature, high-powered processers, we're moving into a world where machine intelligence will permeate every layer of the technology stack. Amplified by the rise of cloud-served supercomputing, this combination of technologies means that any massive-scale intelligence can be connected and accessed virtually anywhere for almost any purpose. As we move into a world of on-demand machine intelligence, everything from toys and cars to industrial maintenance systems will be able to interact, respond, and learn the most effective ways to work with humans and robots.

windriver.com

Performing predictive maintenance

Wind River Systems blends analytics from discrete parts of systems to automatically analyze and adjust a system for optimal performance.

kickstarter.com/projects

Accessing Watson in a toy

Elemental Path developed a toy dinosaur that connects to IBM's Watson to interact and age with children in individualized ways.

EVOLVABLE HARDWARE
upgradeable and adaptable objects

Foundational Technology 4
DISTRIBUTED COMPUTING
toward **cloud supercomputing on demand**

Foundational Technology 7
HUMAN-MACHINE INTERFACES
toward **enchanted objects**

Foundational Technology 8
NATURAL LANGUAGE PROCESSING
toward **casual communication with machines**

Foundational Technology 5
INDUSTRIAL CONTROL SYSTEMS
toward **networked and synchronized systems**

Foundational Technology 17
SENSORS
toward **context-awareness**

Foundational Technology 18
ROBOTICS
toward **machine driven productivity**

Foundational Technology 14
BLOCKCHAIN TECHNOLOGIES
toward **a decentralized transaction network**

the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

| Combinatorial Forecast | **4** | **EVOLVABLE HARDWARE**
upgradeable and adaptable objects |

As more and more of the objects and infrastructures in our lives include both hardware and software components, we're moving into a world where machines no longer have fixed functions. In much the same way that we've become accustomed to upgrading phones and computers through over-the-air software updates, more of our physical stuff— from cars to home appliances to heavy machinery—will be upgraded and optimized through updating software. As code begins to enhance more of the physical objects of our world, they will effectively become adaptable and self-improving.

nytimes.com

Autonomous driving added through Wi-Fi

Tesla has announced that it will use over-the-air updates to bring autonomous features to previously purchased Model S cars.
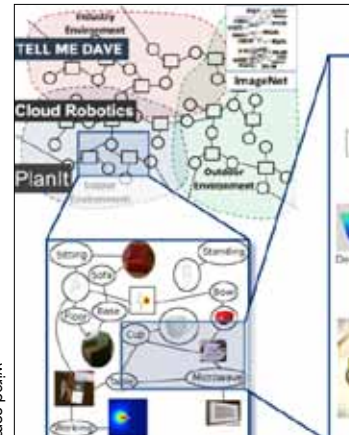
wired.com

Machines learn new instructions from each other

Stanford researchers are building ways for robots to share, access, and learn operating instructions from each other.

ENCODED JUDGMENTS
machine-embedded preferences

Foundational Technology 2
MACHINE LEARNING
toward **anticipatory systems**

Foundational Technology 6
GRAPH THEORY
toward **machines as the new creative class**

Foundational Technology 9
EXPERT SYSTEMS
toward **augmented intelligence**

Foundational Technology 18
ROBOTICS
toward **machine driven productivity**

Foundational Technology 11
DRONES
toward **unmanned matter routing**

the **automated** WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

ENCODED JUDGMENTS
machine-embedded preferences

As our machines become augmented by on-demand intelligence, and as these intelligent machines move into broad domains of human experience, we will—by necessity as much as choice—begin to build behavioral rules and programming norms into the machines that interact with us. In early forms, we'll use fairly unsophisticated strategies. For instance, a prototype breathalyzer will now automatically summon an Uber if its user is above the legal limit for blood alcohol content. Over the next decade, a growing number of judgments—often increasingly complex—will be automated and executed at the point of interaction.

forbes.com

Mitigating robotic crime

An emerging field of law has begun examining the rules governing potential liability issues surrounding bots that inadvertently commit crimes.

nytimes.com

Programming "guilt" into weapons

Georgia Tech developed simulated guilt designed to prevent a robot from using what a human commander determines is excessive force.

DESIGN YOUR
ARTIFACTS FROM THE FUTURE

You can catalyze the change you want to see in the automated world by prototyping your own vision for the future today.

This suit of 6 **ARTIFACTS FROM THE FUTURE** cards describes six scenarios of products, services, and systems of the automated world at different scales. They bring the future forward, giving you an immersive view into the world of the next decade.
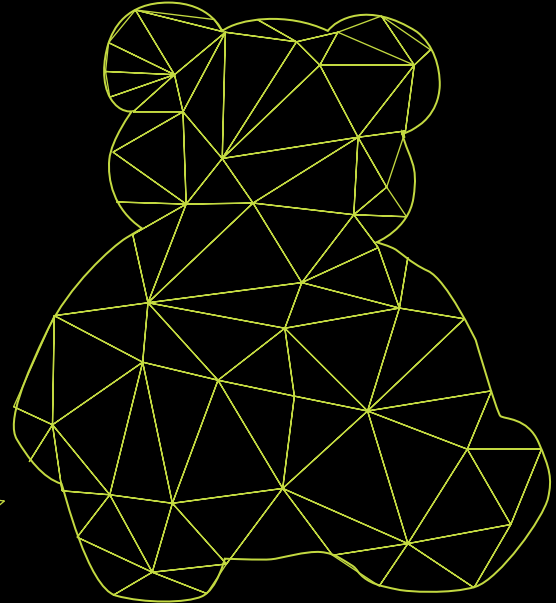
In this step, you'll explore Artifacts from the Future and create an original scenario to tell your own story of human+machine symbiosis.

the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

INSTITUTE FOR THE FUTURE

DESIGN YOUR ARTIFACTS FROM THE FUTURE
instructions

Designing Future Artifacts

① **Describe the future** at a critical intersection from the matrix from the previous step by answering, "What is being automated? To what end? For whose benefit?"

② **Highlight the technologies** of an automated world in your story to explain how this future will be possible.

③ **Make the future tangible** by creating an interaction, object, person, or place that represents the transformational nature of this future.

④ **Bring your future forward** by telling a story about your interaction, object, person, or place using text and illustrations.

⑤ **Sketch your Artifact from the Future**

GITGRUB
snap together your business

GitGrub Snack Delivery

Explore Features Enterprise Blog

GitGrub

drag & drop:

Choose a Delivery Method:

click to add

drop here

Upwork

WORKER

Delivery Method

Marketing

Payment

Box

GITGRUB
snap together your business

WHAT:

When the bus drops off Aiden and Ben at school, they dash to work on LaunchBox, their afterschool snack delivery company. Tired of only finding junk food at their corner bodega, they'd decided to use a recipe (a set of commands that triggers actions in digital services) on GitGrub, an online repository for food delivery coordination platforms. Today, they sign up 10 classmates as beta testers, download the system blueprint and get to work rolling it out to their classmates.

Source: "Minecraft Boys" by Flickr user Hans Olofsson

SO WHAT:

Platforms like Twitter, Google Maps, and Uber open their APIs so people with little technical expertise can integrate them into existing or entirely new services. Sites like GitHub and If This Then That act as open code repositories and recipes for actions and connections among many platforms. As these systems multiply and become increasingly interconnected, even children will be able to leverage machine learning algorithms to remix, reconfigure, and assemble organizations as easily as building a webpage from plug-ins.

AUTOMATE YOUR R&D

EKIN

CASE STUDY:
DISRUPTING ATHLETIC SHOE PATENTS

FIG. 1

PATENTS FILED:

1980

1
AIR SOLE SHOE
CUSHIONING

FIG. 1

2014

544
MARTY MCFLY
AUTO-LACING SHOE

2025

2,700
SOIL BACTERIA DNA
SEQUENCING SOLE

XPRIZE
WINNER!

LECTUAL
UREBOT

the
automated
WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

AIVENTUREBOT
capture value before your competition

WHAT:

People can't stop talking about Nathan Vladmhyr, CEO of AIntellecual Venturebot, and his keynote at TechBlast2025. The patent game changed when he developed an algorithmic patent creation bot to automate the discovery of disruptive, non-obvious IP. Every R&D department wishes they'd hopped on board as early as the sporting goods company Ekin. In 2025, AIntellectual Venturebot drafted over 2,500 patents for new digital activewear technology. Elkin simply had their human lawyers file the patents formally.

Source: Nate Lanxon – Wired.co.uk

SO WHAT:

While early artificial intelligence successfully used algorithms to do highly quantitative, rote tasks at unprecedented speed and efficiency, now machine learning and other forms of AI can be used to do work once thought to require human creativity. AI will begin to take on basic research tasks in a variety of fields— from medicine to product innovation—and create computationally driven intuitive leaps to amplify, and even replace, the basic foundations of intellectual property and discovery.

HEADSTART
personalized learning and teaching toys

HEADSTART
personalized learning and teaching toys

WHAT:

You never thought you'd buy your five-year-old a stuffed animal with built-in cutting-edge cognitive computing. But soon after a 2023 study shows that children with AI companions scored much higher in intelligence and sociability, you find yourself in an aisle of the Head Start store. What kind of parent would you be if you didn't buy toys that adapt to Sam's learning style? You pick up the foreign language expansion pack, expecting Sam to be fluent in Mandarin and Spanish next year.

Source: "FAO Schwarz" by Flickr user m01229

SO WHAT:

Artificial intelligence is becoming an on-demand service—available as needed and embedded into a wide variety of objects beyond computers and phones. As this kind of intelligence becomes available and embedded in natural, intuitive ways into household objects, people will need to make difficult decisions about how integrated they want to be with machines around them. From cooking to calendaring, from child-rearing to relationship counseling, individuals and families will have to choose how to integrate smart assistants into the dynamics of the family.

DATA POOL
self-managing machines

- Syncs with Mall Mart same-day shopping profiles for effortless detergent re-ordering*

- Compatible with all home automation systems

datapool

Connect to your DataStar Profile!*

*$19.99 monthly restocking and maintenance quote. Data subject to mining and re-use by Datapool and its affiliates for marketing and research purposes. Washer service may be terminated without prior notice upon breach of terms and conditions.

DATA STAR

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- Syncs with Mall Mart same-day shopping profiles for effortless detergent re-ordering*

- Compatible with all home automation systems

Connect to your DataS

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- 10kg Front Load SmartWasher
- DataStar smart contracting negotiates with utilities and power-hungry appliances to get you the best deal for your load.
- Syncs with Mall Mart same-day shopping profiles for effortless detergent re-ordering*
- Compatible with all home automation systems

datapool

99⁹⁹

(with activation of data & restocking plan)

Regular Price
(without activation)

399⁹⁹

the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

WHAT:

With the Datapool self-managing washing machine, you'll never have to shop for detergent or replace a part again. This worry-free machine picks the right detergent, senses when it's low, and purchases for you. The automatic update system tracks laundry science to make sure you have the latest wash cycle software for every load. In case of a hardware issue, it can dispatch a trusted network repairman to your door before you even realize anything's wrong.

SO WHAT:

Today's technology makes it nearly effortless to order just about any item at any moment. Already, people are removing commodity items from their grocery lists and ordering them through mobile devices when they run low. As household objects become connected to the Internet and embedded with secure protocols to execute transactions, we'll be able to program them to make purchases on our behalf, making machines a new consumer segment and forcing retailers to innovate in marketing to them.

HUMAN REROUTER
optimizing flows of people and traffic

Artifacts from the Future **5**

CITY OF KENGA-SHI
HUMAN MOVEMENT
AUTOMATOR

PROCESSES
OPTIMIZING...

CS: HANDICAP CROSSING

CS: PEDESTRIAN CROSSING

TRAFFIC

◇ HANDICAP PRIORITY
REDIRECTING PRIUS
license AVX-7013

sustainability...98%

walkability...100%

efficienc

BCK > RGL

the automated WORLD
TOWARD **HUMAN+MACHINE** SYMBIOSIS

HUMAN REROUTER
optimizing flows of people and traffic

WHAT:

When a boy in Kenga-shi searches for directions to the park or a woman asks for a scenic, speedy route to work, the city-wide human movement automator cross-references contexts and intentions with other travelers and suggests an optimal route and means of transport. In 2022, Kenga-shi installed sensors at major intersections and asked residences and businesses to open street-facing cameras for city use. Integrating public and citizen-donated personal data, the system adjusts to optimize density.

SO WHAT:

Many platforms, such as Waze, already use data about human movement, intention, and preference to help coordinate the movements of massive numbers of people. As cities install infrastructure for data capture as well as networked, programmable infrastructure such as traffic lights, they'll have the capacity to automatically direct many aspects of human experience. Such systems will enable city operators to orchestrate human actions toward specific goals, such as sustainability, efficiency, civic participation, or economic activity.

Source: "Space Station Flight Control Room" by Flickr user NASA
and "Mission Control" by Flickr user Milestoned

WHAT:

Emma and Laila love playing on the tracks, skipping across the rails. But when a train comes within 10 miles, the tracks transform to move the girls safely away. Chicago's Sentient Spaces pilot program takes the concept of multipurpose space to a new level. With lightweight, Internet-connected robotics embedded into nearly every space in a neighborhood, their use can shift several times an hour, drawing on massive city data sources. Building a park over notoriously dangerous train tracks was a controversial and bold choice, but it proved the power of the technology and viability of the project in a way that nothing else could.

Source: "Train Tube" by Flickr user Eric Allix Rogers and "21 Balançoires, Promenade des artistes" by Flickr user art_inthecity

SO WHAT:

Since pedestrian bridges that move to let ships pass, we've had adaptable infrastructure, but costs kept it limited to very large-scale projects. But as lightweight robotics become affordable, we can make nearly any piece of infrastructure, big or small, adaptable. Programmability will allow citizens and algorithms to embed priorities and preferences into public spaces, enabling streets, parks, and trains to transform automatically when chosen conditions are met, including public safety and security.

ABOUT THE
INSTITUTE FOR THE FUTURE

The Institute for the Future is an independent, nonprofit strategic research group celebrating 45 years of forecasting experience. The core of our work is identifying emerging trends and discontinuities that will transform global society and the global marketplace. We provide our members with insights into business strategy, design process, innovation, and social dilemmas. Our research generates the foresight needed to create insights that lead to action and spans a broad territory of deeply transformative trends, from health and health care to technology, the workplace, and human identity. The Institute for the Future is based in Palo Alto, California.

TECHNOLOGY HORIZONS PROGRAM

The Technology Horizons Program combines a deep understanding of technology and societal forces to identify and evaluate discontinuities and innovations in the next three to ten years. We help organizations and communities develop insights and strategic tools to better position them for the future. Our approach to technology forecasting is unique—we put people at the center of our forecasts. Understanding humans as consumers, workers, householders, and citizens allows IFTF to look beyond the technical capabilities and identify the value in new technologies, forecast adoption and diffusion patterns, and discover new market opportunities and threats, as well as anticipate how we will live, work, and connect with one another in the coming decade.

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