



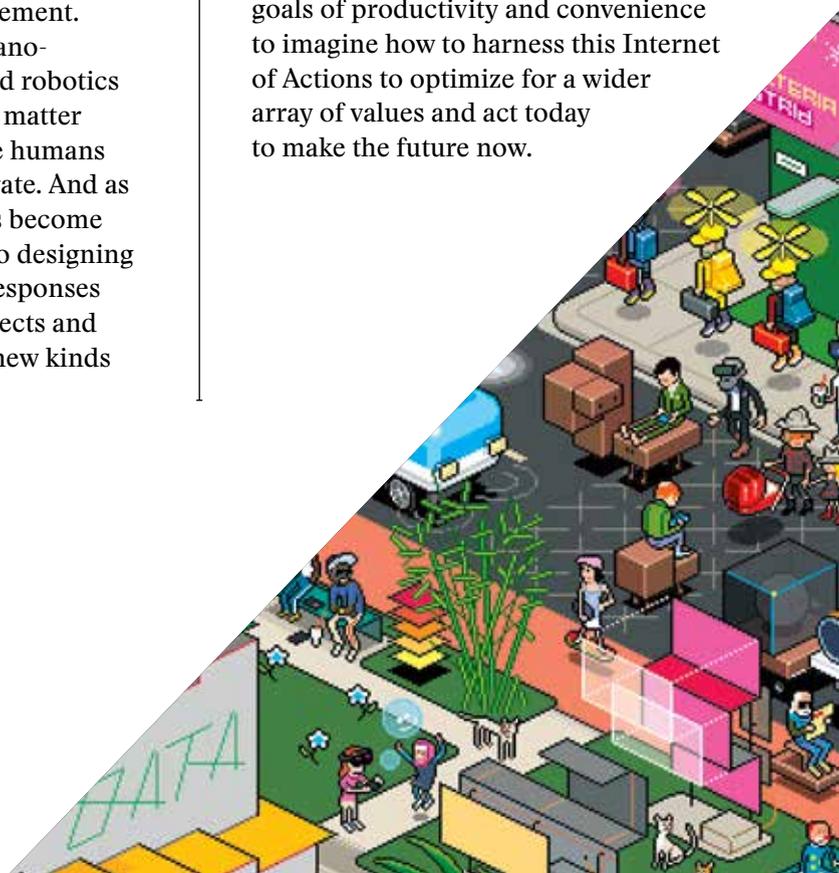
# Reconfiguring Reality

Reality is up for grabs. Over the next decade, advances across the technology stack will combine to reveal a world where inanimate objects speak to us, bots act on our behalf, and networked machines negotiate with each other, hopefully with our best interests in mind. But what values should we encode into these intelligent objects and networked terrains? What do we really want from these billions of intelligent, autonomous machines who will soon share our business, social, and civic spheres?

As intelligent machines proliferate, they'll enable us to reconfigure reality using increasingly sophisticated strategies. Data science and machine learning, aided by insights from psychology and neuroscience, will enable us to create new pathways to alter human perceptions. Ubiquitous sensing, coupled with utility machine intelligence built into every node in the network, will create opportunities to encode human activity in pursuit of profits, personal empowerment, social interaction, and legal enforcement. Advances in fields such as nano-engineering, 3D printing, and robotics will enable us to manipulate matter in places and at scales where humans have never been able to operate. And as voice and gestural interfaces become pervasive, new approaches to designing personality and emotional responses will emerge and animate objects and environments with entirely new kinds of experiences.

As these autonomous machines are introduced and search out ways to be valuable, we'll come to understand their worth not simply through their ability to deliver information. They will form an Internet of Actions, where their value will stem from their ability to orchestrate complex, open-ended actions in myriad ways. But to what end?

The ability to reconfigure reality is full of enormous possibilities that will challenge us to push beyond familiar goals of productivity and convenience to imagine how to harness this Internet of Actions to optimize for a wider array of values and act today to make the future now.



# Toward an Internet of Actions



The Internet of Actions will emerge over the next decade across three time horizons.

## Internet of Information

short-term

For most of the Internet's history, its purpose has been to connect people to each other to share, exchange, and interact with information. In just the last few years, we've connected more things to the Internet than there are people living on the planet. An increasingly diverse assortment of devices is added each year—from pill bottles to light bulbs to juice machines—that function as rudimentary information sensing devices for the physical world. Although these objects are smarter than their traditional counterparts, their primary value stems from triggering simple, often close-loop, interactions, such as noticing if a pill bottle was opened and triggering an alert if it has not.

## Intelligent Things

medium-term

As machine intelligence becomes an easily embedded utility service, our connected objects are becoming capable of more sophisticated machine-to-human interactions. Exemplified by virtual assistants such as Google Home and Amazon Echo, which engage in open-ended communicative exchanges, the value of intelligent things emerges from their ability to understand, access, and deliver information and answers.

## Internet of Actions

long-term

By the end of the decade, networks of intelligent things will be commonplace, robust, and acting in concert—to shape reality on our behalf. These distributed autonomous systems will proliferate, learn from each other, and become prominent actors in business, work, home, and even on and in our bodies. As machines communicate not just with humans, but also with each other in complex, open-ended ways, we'll understand the value of these systems through the kinds of actions they perform, decisions they make and negotiate, and the broad sets of human goals and values they help us pursue.

This is your guide to:

**Tour the future** of the Internet of Actions by exploring the forecasts and strategies.

**Imagine combinations** of strategies and values, and immerse yourself in scenarios.

**Make the future now** by playing the card game to imagine scenarios and artifacts for reconfiguring reality.

**Dive deep** into the companion magazine *Future Now* to understand the opportunities and challenges these strategies create.

# Technology Foundations

## Strategies for Reconfiguring Reality

Advances in machine learning, virtual and augmented reality, robotics, and 3D printing will combine over the next decade to create new strategies for enlisting networked machines to drive business, social, and civic value.

### Altering Human Perceptions

immerse | illuminate | control | influence

Until recently, people in the same place had the same sensory experiences. Barring a physical impairment, people near you would see, hear, smell, and touch the same things you were. Augmentation technologies will dramatically change human experience, altering sensory inputs in increasingly sophisticated ways. Visual and auditory stimuli will augment our visual field with artificial objects and psychoacoustically placed sounds within sensory range. Coupled with advances in sensing gaze, gestures, and haptics, new communication and entertainment forms blending real and virtual worlds will proliferate. People will be empowered by, and bombarded with, **immersive** experiences that dial in different amounts of real and synthetic content. Hidden layers of information will be **illuminated**, and we'll better **control** our engagement with the world. But we'll also be subject to new forms of constructive and counterproductive **influence**. These technologies will deliver more cues for sensing position and motion, and synthetic stimuli will transition from being overlaid intruders in the real world to an inextricable, expected part of everyday experience.

### Encoding Human Activity

embed | execute | rebalance | remix

People obviously exhibit complex behaviors and navigate a vast web of contingent situations. Early efforts to support personal choice via wearable sensors and smart spaces, required determined, proactive users. Current offerings work best in highly circumscribed conditions. Artificial intelligence—machine learning algorithms, biometric instrumentation, incorporation of context, and data fused from environmental sensors—will allow us to codify what people want and enable new applications. Algorithms **embedded** in devices and orchestrating devices from the cloud will operate autonomously. These systems will analyze inputs, detect patterns, find correlations, test hypotheses, draw conclusions, and **execute** results. These systems will improve as advances in machine learning and increased amounts of data enable them to sense patterns and improvise and test improvements. Algorithmic interventions will **rebalance** our lives by simplifying repetitive tasks, enhancing learning, and flagging social opportunities. Other domains will emerge, such as **remixing** wetware with hardware. Tensions among privacy, utility, and public good will persist, creating a divide between those using personal clouds and those surrendering data for perceived benefits.



### Manipulating Matter

model | make | swarm | route

Our ability to create objects and environments that suit our tastes is transitioning to a mix of personal authorship, accurately modeled form and function, and automatic adaptation. Broad swaths of our environment will be altered moment-to-moment as the on-demand pace accelerates. Developments in novel materials with reconfigurable appearance and customizable fabrication will combine to support fluid expressions of appearance and function. Rather than selected as off-the-shelf products, clothing, consumer goods, furnishings, interiors, and facades will be a flux of customization and tweaks—authored and specified, **made** and delivered at the ideal time. Brands will offer palettes for individual expression, and a new stripe of designer/curator will attract a following by creating specific items and looks. Robots, drones, and integrated intelligent machines, incorporating novel materials and physical properties, will become widespread at micro and macro scales. These devices, operating as single units or collaborating **swarms**, will be privately owned or deployed as services. The devices will **route** matter to enable ongoing transformations in the home, boutique service bureaus, and distributed industrial settings. These advances will amplify and extend human capabilities to places and scales beyond our current reach.

### Animating Objects and Environments

infuse | anticipate | visualize | orchestrate

Humans are used to explicit control of machines, but that won't be the case much longer. Breakthroughs in natural language processing, conversational interfaces, gestural inputs, and affective computing will **infuse** machines with increasingly lifelike interactive capabilities. Expanding artificial intelligence and decision-making abilities will enable objects and environments to **anticipate** actions we'll appreciate and value. Our technological systems will exploit these new modalities—one may act like a kooky pet, another like a confidante. Some subset will still respond to our bidding. As affective computing systems become the norm, some spaces and devices will accommodate our moods, **visualizations**, and attitudes, while others will try to shape our behaviors, both explicitly and implicitly. Negotiations with our devices and systems will occur as our devices and environments **orchestrate** themselves to tailor themselves to circumstances. The times we're greeted with an ideal beverage or entertainment that buoys our mood will outnumber times we ask spaces or devices to explain why they took an action. Interactions with a world animated with intelligence devices can tune our expectations and shape our responses to assumptions.

# Altering Human Perceptions



**Virtual reality**, coupled with advances in **haptic interfaces**, will open up new frontiers in learning by immersing us in digital communications that create fully embodied experiences to make ideas and information intuitive.



As increasingly **sophisticated analytics** enable third parties to illuminate hidden preferences, retailers will engage in ever more cutthroat battles to understand consumer preferences and appeal to our **desires**.



Video filters aimed at improving our appearance will progress and become tools to create **lifelike spoofs**, blurring lines between improving, sharing, and losing **control** over how we're perceived.



The proliferation of **computational propaganda bots** will accelerate efforts to enlist bots to **influence** public opinion on everything from election and voting choices to brand identity and advertising.

Scenario

## The Fleet

**What happens when fleets of autonomous cars battle it out for the same street corner?**

As fleets of autonomous cars make their way into crowded city streets, new systems of interaction design emerge to ensure reliability. Embedded algorithms interact with each other and with on-demand tech support, developing strategies and systems that influence everything from tiered pricing to evaluating human job performance. When autonomous machines are constantly negotiating with humans and other machines, how do they explain themselves in ways that can be understood?

Advances in **machine learning** will cause profits to accumulate in the hands of a few platform owners, creating new efforts to rebalance who benefits from Internet of Actions systems and to rethink what counts as a **universal basic asset**.



# Encoding Human Activity



**Smart contracts** will get embedded into street signs, roads, and other lightweight Internet of Things infrastructure to usher in a future of automatically enforced local laws, renewing efforts and focus around **homegrown governance**.

Extreme debates on the morality of **embedding the rules of warfare** into autonomous weapons will shed light on the kinds of actions humans and machines should or should not be empowered to **execute**.



Natural and artificial intelligence will merge, as breakthroughs in neurobiology enable researchers to **remix the wetware of the brain with traditional hardware**, unleashing computing advances powered by neural tissue.



# Reconfiguring Reality

Toward an Internet of Actions



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Scenario

## The Caregiver

**What happens when your health is dependent on an upgrade you can't afford?**

As intelligent autonomous objects proliferate, they can be seen as empowerment tools to make us more capable and independent. This is especially true in the home and in adaptive aging-in-place centers where advances in mixed reality, conversational, and other intuitive interfaces are supporting caregiving efforts. But as we come to rely on networks of machines provided by different companies for caregivers, how do we ensure reliable service and equitable access?



Both humans and bots with sophisticated, simulated personalities will **infuse** personality into our spaces and objects and **inhabit machines** from a distance to experience, affect, and take control of places we could never go before.



Volumetric video capture, coupled with the emergence of augmented reality, will give us the ability to **visualize** past events and create **persistent, reliable memories** in situ.

To improve performance and prevent breakdowns of machines, factories and manufacturers will use **digital twins** to **model** performance under myriad conditions in virtual environments.



3D printing and other manufacturing technologies, increased tracking of consumer behavior, and predictive algorithms will allow systems to autonomously develop and **make** products, ushering in a retail landscape shaped by **anticipatory manufacturing**.



Scenario

## The Pass

**What happens when infrastructure enforces the law?**

As public spaces become increasingly reconfigurable, and infrastructure becomes capable of intelligently tracking, interacting with, and controlling citizens and visitors alike, lines between public safety and overreach blur. Innovative local governments experiment with systems of embedded governance for real-time, services that aim to do everything from manage traffic in public spaces to promote public health in order to maintain and optimize public good. When local law becomes embedded and automatically enforced, how does it shift the balance between public safety and privacy?

# Animating Objects and Environments



As deep learning systems generate new kinds of knowledge and findings, developers will seek to create machines that **anticipate** how to **explain themselves** in ways, and with strategies, optimized for human understanding.



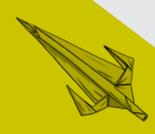
**The Internet of Food** will emerge as restaurants and home chefs create new types of optimized eating experiences by **orchestrating** connected, seemingly mundane objects to enhance age-old experiences of eating.

## The Ruse

**What happens when products lie?**

Advances in multimaterial 3D printing render intricately designed objects called **roshkis** into intelligent commodity machines using sensors and ambient energy. In an effort to grow razor-thin margins, roshkis begin to invent backstories, including fraudulent ownership histories from synthetic celebrities, proven through simulated ownership behavior of the "previous owner." Just how far will our possessions go to deceive their owners in pursuit of increasing perceived value and profit?

100% VIRTUAL CELEBRITY-OWNED



Brain-computer interfaces will create **telekinetic**-like capabilities and enable people to **route** machines with their minds, control software by thought, communicate telepathically with other people—and even learn through brain stimulation.



Sophisticated machine vision and location sensing will allow for **robots to work together** in precise but unplanned ways and **swarm** to collaborate on everything from mundane household chores to disaster rescue and high-stakes surgeries.



# Manipulating Matter

**Make the Future Now**  
by playing the game  
and imagining scenarios  
and artifacts to  
reconfigure reality



STRATEGY

OBJECT



# Make the Future Now

WILDCARD

VALUE

TERRAIN

**Play Cards**  
with the accompanying  
deck until the game board is full  
to create a design prompt:  
What scenarios could the combination  
of concepts in these cards produce?  
Play a wildcard to create an added challenge.

Share your favorite ideas by tagging with **#futurenow**

STRATEGIES

Ways we can catalyze bots  
and machines to take  
action in the world and  
reconfigure reality

OBJECTS

The material things that  
can be enlisted to take  
action in the world

TERRAINS

The location or thematic  
context in which the  
future unfolds

VALUES

Priorities that we will  
encode in billions  
of intelligent and  
autonomous  
machines



# Reconfiguring Reality

Toward an Internet of Actions



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## Institute for the Future

Institute for the Future (IFFT) is an independent, nonprofit 501(c)(3) strategic research and educational organization celebrating nearly 50 years of forecasting experience. The core of our work is identifying emerging trends and discontinuities that will transform global society and the global marketplace. Our research generates the foresight needed to create insights that lead to action and spans a broad territory of deeply transformative futures, from health and health care to technology, the workplace, learning, and human identity. Institute for the Future is based in Palo Alto, California.

## The Future 50

This work is supported in part by IFTF's Future 50 partnership—a circle of future-smart organizations that think strategically about near-term choices to reshape the long-term future. Future 50 draws on a half century of futures research from our labs focusing on society and technology, the economy and the environment, food and health. Its goal is to create the perspectives and expert viewpoints, the signals and the data, to make sense out of disruptive forces in the present. Grounded in a framework of Foresight-Insight-Action, the Future 50 partnership invests in critical research, boundary-stretching conversations, and strategic experiments that will shape the business, social, and civil landscapes of tomorrow.

## Tech Futures Lab

IFTF's Tech Futures Lab combines a deep understanding of technology forces to identify and evaluate discontinuities and innovations in the next three to ten years.

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