Designing for the Machine-Centered World

As machines drive more buying choices, we must accept them as a new customer group and change how we design, describe, communicate, price and present products and services to them.

innogy

INNOVATION HUB

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MACHINE ECONOMY

by innogy

Introduction

In late 2016, a child in Dallas asked her family's Amazon Echo "Can you play dollhouse with me and get me a dollhouse?" The device ordered a dollhouse for her. When a news anchor repeated the story, the phrase "Alexa ordered me a dollhouse" triggered Amazon virtual personal assistants (VPAs) in the homes of viewers to also order dollhouses for their unwitting owners.

In spring 2017, an advertisement for Burger King included the line "OK Google, what is the Whopper burger?" Which prompted any Google Home VPAs within earshot to begin describing the burgers to their owners?

In the future – perhaps the near future – your autonomous car will not only decide when it needs maintenance, but shop for the best price, schedule an appointment and drive itself to the shop. If it is an electric vehicle, it will shop for charging stations and drive itself to the location with the best price and the most open charging poles. A little further in the future it might even own itself and run its own ride-sharing service.

These are not just cute anecdotes or isolated examples. They're the opening shots in an economic, cultural and possibly political revolution in which products and services are designed primarily not for people, but for the increasingly smart machines we will trust to make purchases for themselves as well as for their human owners. Increasingly, such machines are becoming autonomous economic agents not only supplementing human judgement but sometimes replacing it.

Marketing Fraud Writ Large

What humans can invent, humans can cheat – as we've already seen in the Burger King ad. Expect more sophisticated "gaming" of machine to machine marketing channels, requiring preventive/remediation steps in areas such as:

- How secure are blockchains, especially with challenges such as how to assure the identity of blockchain nodes (and human users) and the threat that quantum computing can crack the strongest encryption.
- How to prevent the compromise/corruption of data such as user location, customer ratings of products/services or past purchases that might affect which products or services the algorithm recommends. (One report suggested that Burger King edited the Wikipedia entry for its Whopper before running the ad to make the entry read like an

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Combine these rising levels of machine intelligence with blockchain's ability to provide secure, immutable transactions without a middleman and the upside is transformative. Think of a decentralized economy that allows smart machines to find each other and complete transactions at zero cost. Think of the efficiency when new providers of goods and services can compete regardless of location or the quality of their local banks and legal systems. Think of the new business models enabled by fast, secure, zero cost nano transactions on blockchain technology or of smart devices in the Internet of Things (IoT) generating, sharing and even trading data for profit.

The building blocks for this new reality are already falling into place. Consulting firm Gartner estimates the IoT will comprise 26 billion devices and a $1.9 trillion economy by 2020, and the World Economic Forum estimates that by 2025 10 percent of all global domestic product will be stored in the blockchain.

The result are new "algorithmic profits" in which blockchain-based smart contracts allow consumers, or even self-owning entities such as fleets of autonomous vehicles that are electric and shared (FAVES) to monetize their value at the edge of the network. For example, such a self-owned vehicle could make money by selling part of its electric charge back to the electric grid at a charging station, or by selling the transport of people or goods, in a direct machine to person or machine to machine transaction. By using

(continued)

advertisement.) That raises the possibility of customers getting tainted information, and that a hacker could edit the entry with false, defamatory or embarrassing content.

- How to prevent, or at least assure the disclosure of, the promotion of products and services in return for payment. In the worst case, the machine may make a recommendation based only on the payments it receives from the seller without disclosing that arrangement to the buyer. In the best case, the machine uses the data it receives to choose the best possible offer for the customer. In either case, everyone from marketers to regulators needs to realize the need for new thinking, new designs and new decisions about what is desirable in the machine economy.

blockchain, this transaction can happen without the expense, delay or loss of control of going through a central authority such as a bank.

However, the failure to master machine-centered design poses massive and perhaps existential challenge for the many companies that are often still learning to use "human-centered" design. Such human-centered design thinking uses detailed observations of people and multiple iterations of businesses processes and products, Web sites and user interfaces to create innovative products and services to attract the most customers. In the machine-centered world, this design process must be adapted to the algorithms and software that will increasingly make buying (and selling) decisions on their own. For example, how do you convince Alexa (the voice on Amazon's VPAs) to recommend your dish soap to a given set of customers, or a smart thermostat to order electricity and maintenance from you rather than a competitor?

In the human centered world, successful innovation means finding a good fit with unmet customer needs and achieving high traction in the marketplace[1]. In the machine centered world, successful innovation means finding and filling the unmet needs of your machine "customers" and gaining traction in a world of autonomous, algorithmic customers.

The Technology Drivers

The building blocks of this revolution include:

- Increasingly intelligent and capable voice recognition. This is the seductively easy to use interface into the networked, intelligent, "machine first" world.
- Low price and easy to use VPAs that bring natural language queries from the mobile, smartphone environment to any room in the home.
- Integration of such VPAs with e-commerce ecosystems such as Amazon, voice-enabling existing capabilities such as product recommendations and one-click ordering.

[1] Sauberschwarz/Weiss (2017): "How corporates can win the race against disruptive startups", in: "Digital marketplaces unleashed", Linnhoff-Popien, Schneider, Zaddach (Eds.), Springer, Berlin, 2017 http://www.springer.com/br/book/9783662492741

- "Smart" appliances and control systems (ranging from door locks to thermostats) and IoT devices and sensors that can assess their surroundings, gather information from other devices, and use Internet connections to respond to commands from their owners or take action on their behalf.
- Artificial intelligence (AI) and other analytics that gain insight from big data, taking into account not only customer demographics and purchase history but context such as weather, a user's location and activity, or social media and other behavioral clues to what the human speaker might want or need. In pure machine to machine interactions, it might consider production trends to order raw materials for a warehouse, and pricing trends (such as peak period electric charges) in deciding when to charge an autonomous electric vehicle or where to build and deploy autonomous vehicles[2].
- The emergence of decentralized, peer to peer services (such as the Arcade City ride sharing service) and of autonomous, perhaps self-owning vehicles that could sell their own services through such networks, with the ordering being done by voice.

All this creates a new class of "machine" customers that today helps humans decide what to buy, when to buy it, how much to pay for it and from which provider to purchase it. In the fast approaching machine age, everything from autonomous cars to swarms of intelligent nano-satellites to manufacturing robots will purchase products and services for themselves more quickly and less expensively than any human could. (See Figure One.)

[2] Goodbye car ownership, hello clean air: welcome to the future of transport. World Economic Forum December 16, 2016.

Figure One:

Today

- Transactions amongst people and companies
- Transactions being orchestrated by legacy processes and systems with many manual activities involved
- Machines not perceived as the customers of the future; a strategy for 'machines as customers' is needed

Tomorrow

- Transactions amongst
  - People & companies,
  - Machines (M2M)
  - People, companies & machines
- Transactions highly automated & orchestrated via Blockchain with massive impact on today's processes

Example Insight

Banks not yet prepared to offer products for the M2M economy.

Global players such as VISA starting now to invest into Blockchain and IoT to offer nano-transmission services.

Growing share of M2M Transactions

Source: Carsten Stocker (innogy Innovation). US and EU Research / Government Projects. Investment Banking Reports.
M2M Machine to Machine Transactions
◄- - -► Not yet existing transactional interfaces into M2M economy

Designing products and services for this new breed of "machine" customer is a massive challenge, and opportunity, for producers of every product and service on the planet.

The Machines Behind the Machines

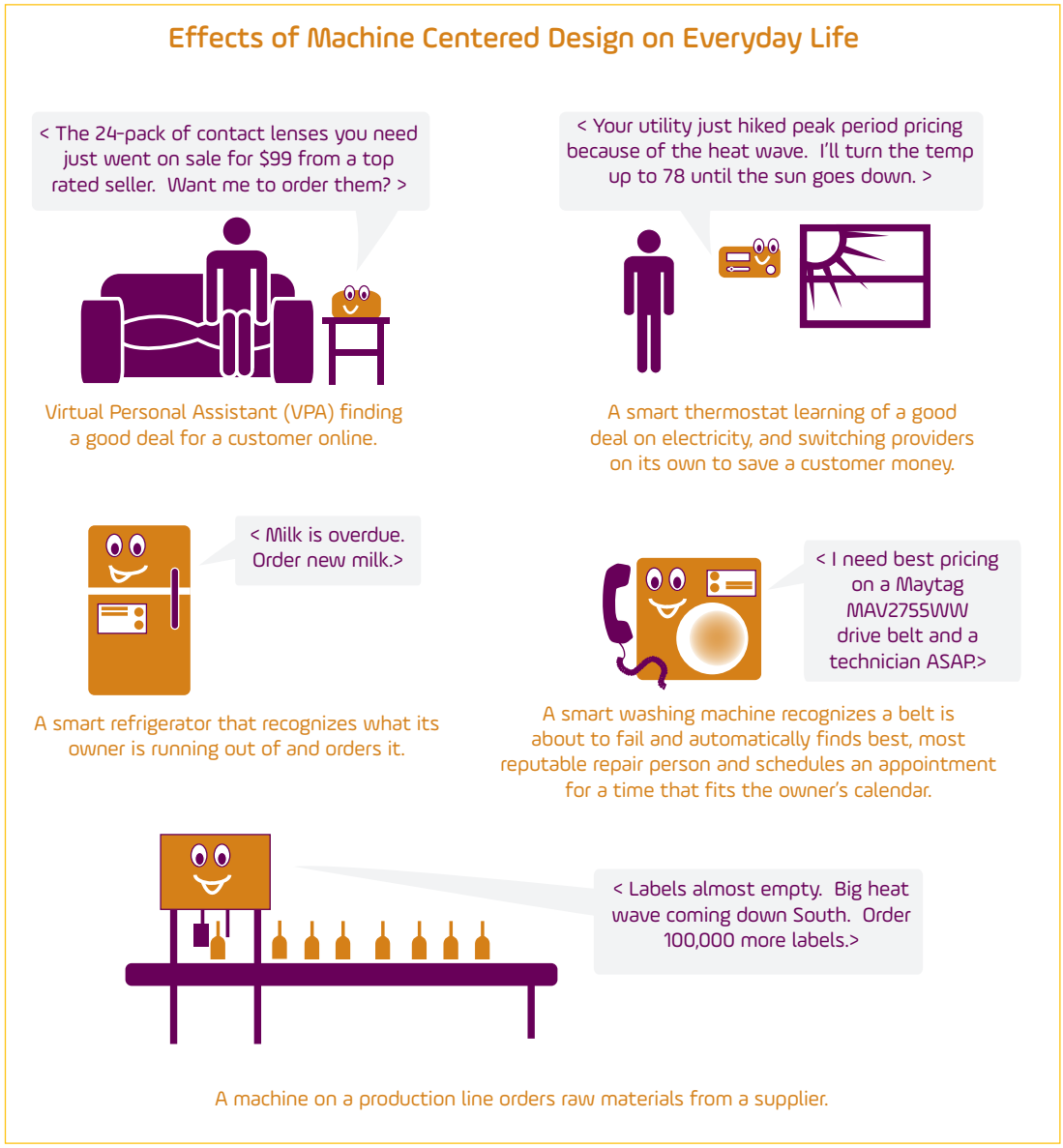
The word "machines" is misleading as most often the "purchaser" will not be the physical devices that appears to be facilitating the transaction (such as a smartphone or VPA) but the algorithms and network that matches buyers and sellers. (See Figure Two.) Among the components in this "machine" marketers will need to design for include:

- The APIs through which information aggregators, peer to peer networks, cloud-based analytics platforms or ecommerce providers accept and share information about buyers and sellers.
- The algorithms that decide how to rank various metrics (such as price, location, delivery time and product ranking) in determining which products or services to offer which customers at which times, and which products or services to buy at what price.

- The blockchains (distributed ledgers) that reduce cost and delay in transactions by eliminating arbiters and gatekeepers such as banks, and enable autonomous (and even self-executing) machine to machine transactions.

The autonomous physical robots that will do routine work from delivery to cleaning to security monitoring and that will need goods and services (such as supplies and maintenance) to complete their work.

Figure Two:



My Robot Will See Your Robot in Court

In today's society, liability issues – who pays if something goes wrong – must be resolved before any new product or service can gain widespread acceptance. The same is true for the machines that will increasingly make decisions for us. If an autonomous device (or process) becomes causes financial or other harm, who is responsible?

Designers of such systems should begin working with regulators, lawmakers and lawyers now to understand the risks and design the legal/regulatory frameworks that provide proper protection to all stakeholders. One example, from an EU proposal, suggests that "...the greater a robot's learning capability or autonomy is, the lower other parties' responsibility should be, and the longer a robot's 'education' has lasted, the greater the responsibility of its 'teacher' should be."

Designing for Machines

- Currently, most companies focus on design thinking or similar forms of human-centered design. They combine these methods with lean and agile development for fast prototyping and user testing, but with a clear focus on human customers. They seek to understand human needs through observation, interviews and market research, and develop ideas to meet those needs through brainstorming and "green field" thinking. They then use fast prototyping, minimum viable products (MVPs) and user testing to speed new products and services to market[3]. (See Figure Six.)

Machine-centered design requires many of the same steps, but implemented very differently to satisfy our new, non-human customers. Developing a "hierarchy of needs" for machines, and defining the machine road map and a machine's "customer journey" can help you define and meet those needs.

What Your Machines Want, and Why

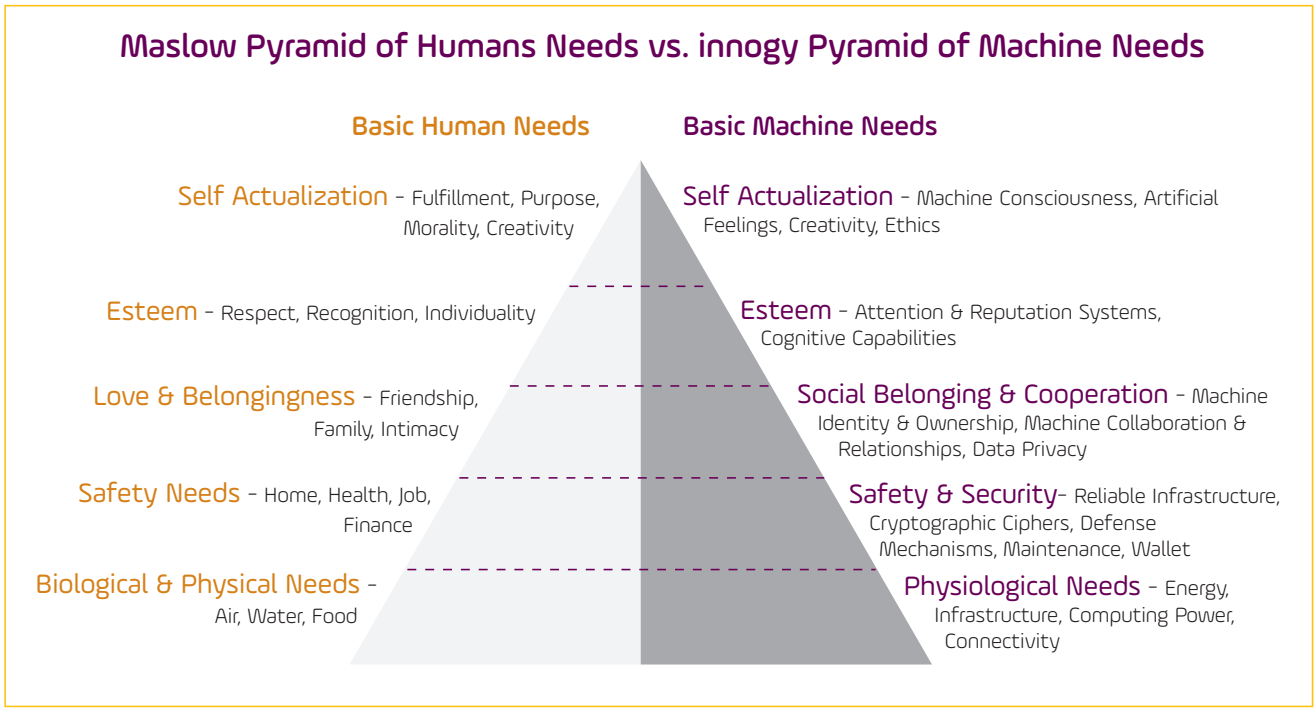
A "Hierarchy of Needs" for Machines

The "machine" for which products and services are designed might be an autonomous car, an industrial robot, or a deep learning algorithm parsing a customer's economic activity. This machine "customer" might be empowered to make a purchase decision itself, only assist with a purchase or recommend a purchase, or serve as the interface for the request, such as Amazon Alexa or another smart speaker.

One way to identify unmet machine needs is use the "innogy pyramid for machine needs" developed by the Machine Economy Lighthouse in the innogy innovation hub (See Figure Three) and adapted from Abraham Maslow's pyramid of human needs.

[3] Sauberschwarz/Weiss (2017): Das Comeback der Konzerne, Vahlen Verlag (German)

Figure Three:



For humans, the base of the pyramid consists of physiological needs such as air, water and food. Once those have been satisfied, the next layer involves safety and security (such as home, health and a job,) followed by social belonging, self-esteem, and finally fulfillment, purpose, morality and creativity leading to self-actualization – becoming everything that person is capable of becoming based on their capabilities and desires. In creating new products and services, designers try to understand where the target human customer is in the hierarchy and how their product or service can meet, or promise to meet, their needs at that level.

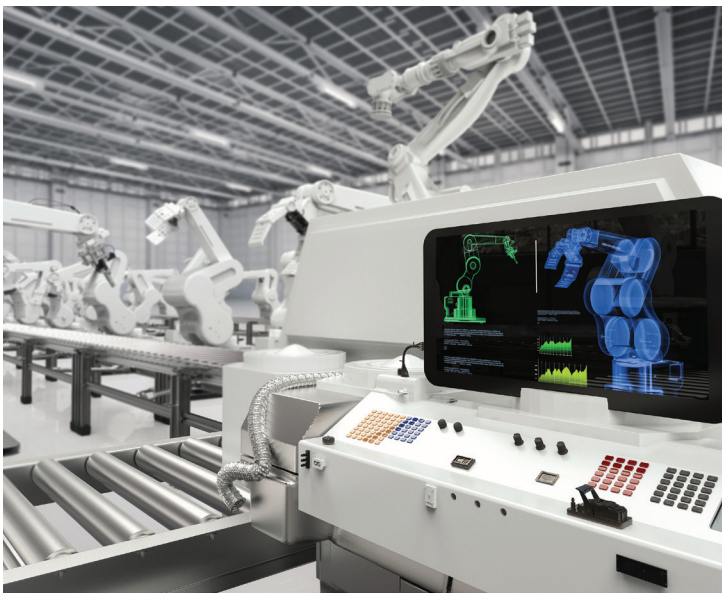
For machines, the lowest level of the pyramid might consist of electricity, computing power and network connectivity. The next level up provides safety and security, provided by firewalls and other cyber defenses, as well as cryptographic ciphers to protect its data.

The next layer up for a machine might be "social belonging and cooperation," meaning the machine has a discoverable identity, can make its presence known to other devices, and can control the privacy of its own data.

Moving to the next layer provides the machine equivalent of self-esteem. This requires "attention" systems that allow autonomous systems to find and identify each other, and reputation mechanisms such as metadata that track how others have ranked the quality of their goods and services.

All these capabilities will allow the machines to autonomously choose which counterparties they will share data, value or services with, and on what terms.

Just as "self-actualization" means different things for different people, it will mean different things for different machines. For a VPA it might mean detecting even the most subtle stress notes in its owner's voice and automatically suggesting music that has calmed them in the past. For an autonomous nano-satellite it might mean choosing its own surveillance targets that result in higher profits for its commodity-trading or agri-business customers.



One possibility is that as machines become ever more capable, this self-actualization may include the ability to experience and express feelings, creativity and empathy. At this stage, they may be able to engage with humans as peers, allowing them to tap Big Data analytics to sense unmet human needs and create new products, services and business models to serve them.

If this "self-actualization" only meets the needs of the machine, the very real fear is they could use their increasing and perhaps superior powers to enslave or even exterminate humans to build a society around their own ever-increasing powers and needs. Elon Musk, the CEO of electric car maker Tesla and SpaceX has said that AI is an existential threat that must be regulated before it is too late[4] and famed professor Stephen Hawking has echoed such fears, saying AI will be either the best or worst thing to happen to humanity[5].

This profound question has many companies (including a consortium of AI leaders including Amazon, Facebook, Google, IBM and Microsoft[6]) as well as the nonprofit OpenAI[7] looking for ways to ensure "safe AI" – that machines use their power for good, not evil. In Germany, the federal minister of justice has called for greater government scrutiny of the algorithms that control online information flow to help assure they do not promote discrimination or try to manipulate the democratic process[8].

[4] The Guardian: Elon Musk: regulate AI to combat 'existential threat' before it's too late, https://www.theguardian.com/technology/2017/jul/17/elon-musk-regulation-ai-combat-existential-threat-tesla-spacex-ceo

[5] The Guardian: Stephen Hawking: AI will be 'either best or worst thing' for humanity.

[6] The Partnership on AI to benefit people and society.

[7] OpenAI

[8] Spiegel online: Regulation of Internet Corporations

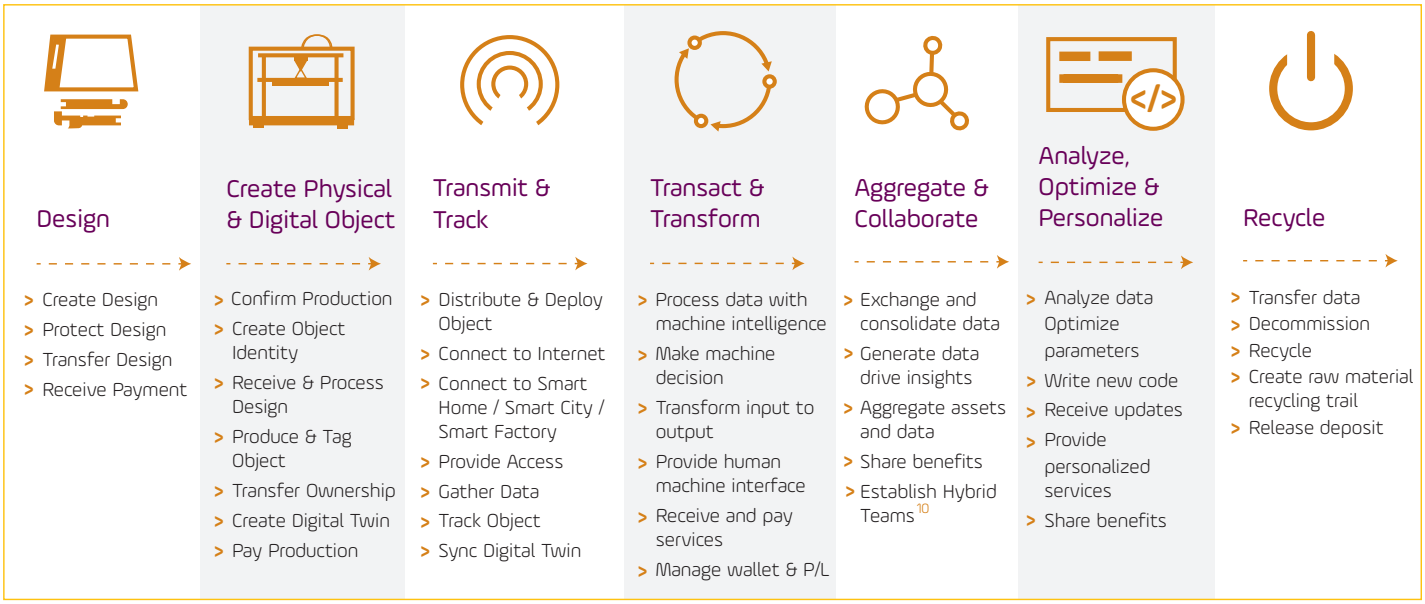
The OpenEth[9] organization is working to create a crowd-sourced, dynamic "dataset of ethics" that will use contributions from people around the globe to teach smart machines how to react ethically to various scenarios.

The Machine Life Cycle

The second tool to understand basic needs of machines is the machine life cycle, from the point where the machine is "born" as it is designed (by humans or other machines) to its end of life when it is decommissioned and its resources (such as computing, storage and network capacity) is recycled for other uses. When designing a product or service for a machine, it's necessary to take into account which stage(s) in the machine life cycle the product or service is meant to address, and how your product or service must change to meet the machine's needs through its life cycle (See Figure Four.)

For example, in the "transmit and track" phase of an electric vehicle's ability to sell electricity back to the electric grid, the vehicle must be able to advertise its presence and capabilities to the grid and to other electric vehicles. In the "analyze, optimize and personalize" stage it needs to analyze data on demand for its electricity and the price customers paid for it, and potentially change its generation and pricing strategies.

Figure Four: The Machine Life Cycle



[9] https://www.openeth.org/

[10] DFKI: Hybrid Teams: Flexible Collaboration Between Humans, Robots and Virtual Agents, http://www.dfki.de/lt/publication_show.php?id=8634

Designers of products and services will need to understand their changing needs and plan for them. Just as a human will need retirement planning at a certain age, an electric vehicle of a certain age may need a new battery or to shop to recycle itself at the best price. More fundamentally, if an aging machine is using an outdated API or blockchain platform, how long is it worth it for other machines to keep supporting these outdated platforms and keep selling to an aging machine? This would be the machine-to-machine equivalent of Adobe abandoning its Flash media player[11] software after complaints from Apple and other technology companies about its bugs and security vulnerabilities.

The Machine Customer Journey

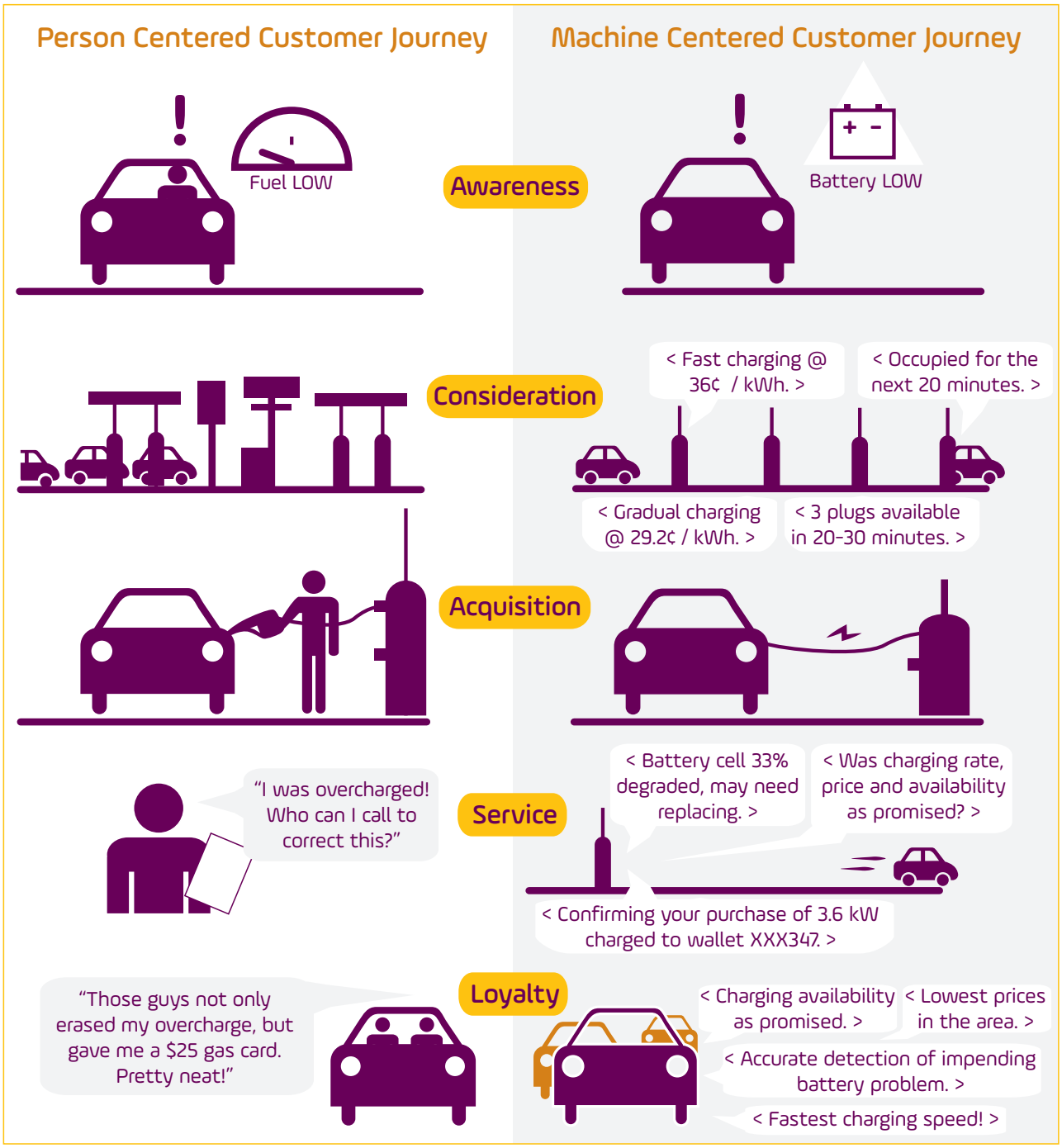
The third tool in effectively designing for machines is an understanding of the machine customer journey. (See Figure Five.) The human customer journey typically progresses from awareness of a product or service (or the need for it) to consideration of a specific provider, acquisition of the product as well as service or support for it, and (hopefully) loyalty to the product or brand, leading either to ongoing sales or recommending it to others. In the selling process, marketers take great pains to understand where a customer is in this journey and tailor communication about their offering accordingly.

Machine customers will go through a similar journey, but with each step conducted over peer to peer networks, executed by algorithms that learn and refine their selections over time, and augmented by attention and reputation systems such as on-line rankings. In the case of our electric vehicle, the "awareness" stage begins when it realizes it needs a recharge, a new tire or a cleaning and advertises its needs to other machines or service providers. The consideration stage happens when various machine "providers" advertise their presence, the pricing, availability, delivery times and other factors. The acquisition is executed via peer to peer smart contracts over a blockchain, as is the ongoing service (perhaps with additional rounds of awareness, consideration and acquisition of new services as needed.) Among machines, the transaction may flow both ways, with a smart contract "agreeing" to sell power from an electric vehicle back to the grid, or a manufacturing robot selling data about its operation in return for a discount on maintenance or parts. In the machine to machine world, the buyer expresses their loyalty through a ranking, on the blockchain, of how well the provider delivered what they promised.

[11] Fortune: Adobe Plans to Kill the Flash Media Player.

At each stage in the design process, this machine customer journey can help product and service providers fine tune their offerings. In the "awareness" stage they can ensure it is listed on the appropriate on-line exchanges, with data describing it in the proper machine-friendly format and providing all the information the requesting machine needs. In the purchase stage, they can assure the transaction was accurate and complete, and in the service stage "meter" the state of the consuming machine to be sure they are offering the right maintenance or replenishment services at the right time.

Figure Five: The Machine Centered Customer Journey



Designing for Machines – the Process

Using tools such as these, here is how the essential elements in the design process differ in a machine-centric rather than a human centric world. (See Figure Six.)

Figure Six: Human Centered Design vs. Machine Centered Design: Elements in the Design Thinking Process

Elements in Innovation Process	Human Centered Design	Machine Centered Design
Goals and criteria	• Business related	• Business related • Serving the (human) society
Opportunity spaces	• Based on trends, customer data and technology research • Based on company and employee abilities	• Based on trends, big data, technology research • Based on company, employee and machine abilities
Insights	• Primary market research: Customer interviews, focus groups, observations, ethnology, transferred into insights • "Personae" as visualization for target group segments	• Primary market research: Data mining and analytics, technical expert interviews transferred into parameters • Machine specs as visualization for "target group" segments
Needs	• Needs based on Maslow pyramid for humans • Customer pain points: Unsatisfied needs from specific persona • Customer journey to identify pain points along specific process	• Needs based on Maslow pyramid for machines • Machine pain points: Unsatisfied needs that hinder specific tasks for specific machines. • Machine journey and machine life cycle to identify pain points along specific processes
Inspirations	• Best practices, analogue examples, look to the future	• Best practice code, open source, patents, technology research, analogue tasks, human interactions as analogy, look to the future

Elements in Innovation Process	Human Centered Design	Machine Centered Design
Ideas	• B2B, B2C offers (products, service processes ...) • Brainstorming to quickly generate ideas	• M2M, B2M offers (services, products, functionalities ...) • Systematic ideation to generate ideas based on relevant parameters • AI supported idea generation, combining different inputs, needs, and parameters
Innovation concepts	• Value proposition with clear value for customer (solve need) • Business model canvas • Customer experience / UX design	• Value proposition with clear value for machine (enable task) • Business model canvas adapted for machines • Machine integration, e.g. API design, language, protocols, parameters • Machine learning and self-learning
Implementation	• Stakeholder: Project owner, customer, employees, partners • Fast prototyping, testing with MVP, agile development	• Stakeholders include project owner, machine (self-owned), investor/owner/manufacturer, programmers, partners • Agile development, A/B testing, fast scaling, Tech review • Design for continuous improvement by the machine customers • Machines must be ready for self-improvement • "Safe AI" must be implemented to assure human safety

Identifying needs and opportunities:

- In the human centered world this is based on analysis of human needs, social and market trends. This often includes traditional market research, focus groups, customer interviews and ethnographic research observing how customers use products and services at work or at home. Target market segments are often described as human "personas" with characteristics such as gender, age, education, occupation, roles and responsibilities and even hobbies. The customer pain points represent unsatisfied human needs at varying levels of the Maslow pyramid, the customer life cycle or journey, with products or services designed to move the customer to the next stage in it.
- In the machine centered world, needs and opportunities are identified primarily by mining and analyzing data on machine to machine transactions, as well as "state" information such as their location and performance. Target markets are described as different classes of machines with different ranges of abilities such as computing power, network bandwidth and storage. Pain points are represented as, for example, unsatisfied needs in the Maslow pyramid that prevent the machine from performing specific tasks or information a machine needs to move to the next step in its journey from awareness to loyalty. The goals, criteria and opportunity spaces should be defined by all relevant stakeholders. In human-centered design, the "stakeholder map" is easily defined and relatively static, including managers, employees, customers, partners and suppliers. It is very different in a fast-paced technology landscape – see sidebar (next comment)

Mapping Your Stakeholders

Every product, whether physical or virtual, has stakeholders – people and/or institutions who have a stake in its success. These range from business managers, employees and shareholders to suppliers, customers, business partners and regulators.

Mapping these shareholders (by factors such as the degree of their influence, their importance and their support for the new offering) is relatively straightforward in the "people" economy. When producing a social media application, for example, stakeholders would include users, advertisers, potential partners, and potentially regulators. While the specific list of stakeholders might change very often, the types of stakeholders will remain fairly static.

The machine to machine world changes far more often and dramatically, producing different types of stakeholders much more often. The reasons, and the implications for those designing for machines, include:

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- New types of devices: Each new type of device becomes a new stakeholder with specific needs and commercial potentials. Autonomous vehicles that can shop for their own tires will create a new, different set of stakeholders for tire manufacturers. A blockchain-enabled sensor that can track temperature and location as well as the source of a product will create stakeholders all the way from the farm to the table, each with different needs.

- New capabilities in smart or autonomous devices: The more and different types of data that, for example, a wearable health sensor captures, the more and different stakeholders will be interested in using that data. The ability to capture signs of stress or specific speech patterns in the owner's voice might, for example, make an addiction treatment center or a probation officer a stakeholder by indicating the user might be at risk of a relapse. When clusters of low-cost nano satellites can cooperate in earth monitoring tasks, the other satellites become stakeholders, as buyers and sellers of data or observing time.

- New data analysis capabilities: As the algorithms that analyze Big Data capture new insights, they will also create new potential customers and regulatory concerns and, thus, new stakeholders. As improved algorithms predict more types of machine failures, they create more stakeholders in those who sell the parts and services that can prevent such failures.

- New transaction platforms: The growth of decentralized transaction platforms such as blockchain slash the time, effort and cost of buying and selling by eliminating middlemen. This democratization of commerce allows new buyers and sellers to enter the marketplace, selling new types of goods and services in new business models. Each of these rapid-fire changes creates new stakeholders with new needs. By allowing, for example, millions of people in under- or unbanked areas to participate in ecommerce, blockchain requires meeting not only their needs but the needs of regulators and banking officials in their geographies. Such new platforms may even be dynamically created in real time to meet rapidly changing requirements.

The lesson: Machine-centered design may focus on machines, but the rise of intelligent, decision-making devices creates a fast-changing cast of stakeholders you must also take into account.

Designing products and services:

- In the human centered world this is built around the capabilities and desires of the target customer (described as concrete "persona"). The effectiveness of the design in meeting their needs is based, again, on interactions with and observation of human subjects, with a heavy emphasis on the user interface as experienced by a human (sight, touch, and hearing.) The effectiveness of the product or service is measured, again, by how well it meets human needs to move a human further up the human Maslow pyramid.

- In the machine centered world, the innovation might be driven by examining where a device or application is on the innogy Pyramid of Machine needs, and what services it could provide an organization (or

society) if it moved further up the pyramid. The effectiveness of the design is measured by how well it meets the technical needs of the device or software for which it is designed, such as efficiency of the code, compliance with the APIs or protocols through which a device or application is addressed, and speed or reliability of the required communications or transactions.

Delivering products and services as quickly as possible:

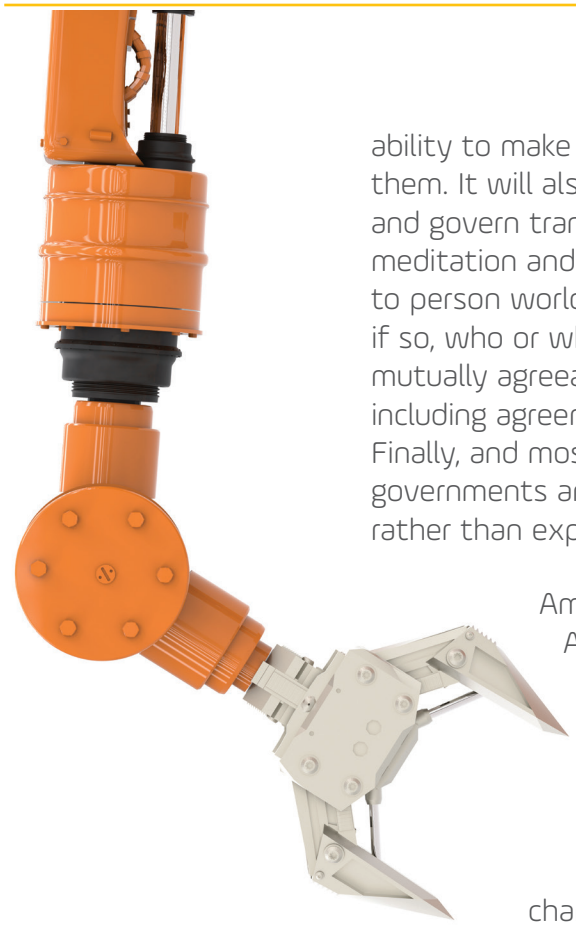
- In the human centered world this is accomplished through agile development methods including SCRUM, rapid prototyping, MVPs (minimum viable products), and DevOps.
- In the machine centered world, these mechanisms are also used, but with the assessment of the solution at each stage relying far more on data analytics and machine learning than "analogue" conversation with or observation of humans. Automated design/test cycles with large numbers of devices or applications in the cloud allow for faster, lower cost refinement of products and services than with human-centered design.

As innovators understand the needs (and potential) of machines rather than humans, they can begin exploring new opportunities for collaboration across industries and borders. This might include an electric utility publishing APIs so it's charging stations can broadcast their availability and prices to fleets of autonomous electric vehicles, or delivery drones dynamically offering security footage to a traffic-tracking application as they travel across a metropolitan area.

Designing for Machines – Infrastructure and Skill

Designing for machines requires new infrastructure, processes and capabilities adapted to this new class of customers. This includes a staff with a timely, in-depth understanding of the logic of machines, the types and volumes of data they generate and consume, and the algorithms and deep learning mechanisms needed to generate insights and decisions from that data. Analysts must understand the business context in which the data, algorithms and insights exist in order to focus their efforts on the "sweet spots" of maximum opportunity.

On the legal and governance front, machine to machine commerce will require common standards for mutually usable smart contracts that ensure both sides understand what the other is offering, as well as the



ability to make counteroffers and to signal acceptance or rejection of them. It will also require laws and regulations that allow for, standardize and govern transactions in the machine to machine world, and provide meditation and conflict resolution comparable to those in the person to person world. (For example, can a machine have a bank account and, if so, who or what has "signing" authority for it?) Finally, it will require mutually agreeable, secure and immutable payment mechanisms, including agreement on which blockchain(s) and cryptocurrencies to use. Finally, and most importantly, as smart machines becomes more capable, governments and citizens will need to be sure they will be used to help, rather than exploit, their human creators.

Among the technical capabilities required are access to the APIs needed to gather the required data, and authentication to prove the supplier is who they claim to be, proper formatting of the data to be shared, support for the level and type of encryption needed to protect the information and the ability to fine tune, in real time, how information is presented to the intelligent ecosystem and eventually the end device, such as a VPA based on changing business conditions.

The data that must be shared includes not only what the machine (or the human it represents) needs (for example, power charging, preventive maintenance or replacement filters for an industrial pump) but the relative importance of factors such as location, how soon the product or service is needed, the quality or level of service required, the price the customer will pay and historic data for the algorithms and smart contracts to consider as they evaluate the current request.

The amount of information required, and the analysis performed on it, can be daunting. For an autonomous electric car, the information required to respond to a seemingly simple charging requests might include how much of a charge it needs and how quickly in order to complete it's current and projected rides, at the lowest cost and losing the least time for charging. The car must factor in, among other thing, the expected demand for rides during the time it needs to charge, as well as historic pricing patterns for power during this time and current and expected congestion on the routes it will take.

Monetizing the Machine to Machine World

In the machine to machine economy, technologies such as blockchain reduce transaction costs to nearly zero. This is good news for buyers and sellers but bad news for banks, credit card processors or other middlemen. As innovators design products and serviced for machines, rather than humans, they will need to take into account who makes money, and how, at what step in the process.

The answer depends on whether the machines provide their services primarily to humans (think of self-driving cars transporting people or a VPA ordering groceries for its owner) or to other machines (think a manufacturing robot ordering maintenance or raw materials.)

When the customer is a human, the service can create value (for which it can charge a price) in the form of greater convenience, flexibility, or ease in either ordering the service or consuming it. Even if the basic service (transportation) becomes a commodity and falls in price, a human might still pay more to go by the shortest route or, conversely, a longer route to pick up a friend or do a chore.

When machines serve other machines, the opportunity to create value (and charge for that value) comes not from customizing the experience for a single consumer but optimizing an aggregation of machines for an aggregation of customers across the network.

For example, when an autonomous electric vehicle wants to make money by selling electricity to the grid, it can charge a premium by, say, waiting for a peak demand period when prices are highest, or even "stabilizing" demand by traveling to a charging station overloaded with demand and transferring extra electricity to another vehicle or by selling the flexibility of its battery to third party aggregator.

In both cases, the matching of supply and demand and the transactions themselves might be performed on blockchains and facilitated by APIs, interfaces and protocols that might themselves provide value as "gateways" to the wider community of buyers and sellers.

Aggregation software that bundles and matches demand will run in a decentralized fashion among network nodes to optimize the efficiency of services such as utility and transportation grids. The software that utilizes algorithms that provide the greatest returns for buyers and sellers can command a tiny transaction fee that will generate algorithmic profits for the owners of those protocols or algorithms. As AI allows the algorithms to improve themselves and compete with lower transaction fees, the result may be a "zero marginal economy" with little or no transaction fees, and no costs to switch among aggregation platforms.

Merely publishing a request from a machine "customer" will require:

- A complete listing of all potential providers of the product or service.
- Knowledge of each provider's fixed and variable states. For the charging station, for example, fixed state includes the payment options/cryptocurrencies it accepts and which blockchains it participates in, the number of charging poles and whether it offers rapid vs. standard charging. Variable state would include how many of its charging poles are occupied (and for how much longer, based on the charging rates of the vehicles they are serving) or down for maintenance, as well as expected future availability based on the number of electric cars nearby and their battery status. It would also include "ratings" from other autonomous vehicles about whether, for example, the charging station correctly reported its availability and charged the price it promised.
- Customization of offers (as price or delivery times) or style (the attitude of a spoken voice or advertisement through a VPA) to meet the current needs of a human or machine. Such customization requires automated tools or manual effort to analyze the selection algorithms currently in use and how to best market to them, as well as tools that let business users easily make changes to content or style of offers without coding and security measures to avoid unauthorized changes to content or offers.

Get With the Program, Humans

For an increasing range of products and services, a person is no longer the decider when it comes to purchasing products and services. Designing products, business processes and user interfaces only for people is not the skill that will determine winners and losers in the machine economy.

In an age of smartphones, VPAs and ecommerce sites that automatically compare prices, the next stop are automated, machine to machine buying and selling. With humans increasingly replaced by (or at least helped by) algorithms, everyone from product designers to marketers must think in terms of developing products for machines, not people. The road to this future will come in stages (See Figure Seven.) with the needs of (and the potential for) autonomous machines rising steadily over time.

Figure Seven: Road to Machine Economy

	1	2	3	4	5
	Past: Human Economy	**Present: Human-Machine Economy**	**Present-to-Future: Machine-to-Machine Economy**	**Future: Human-Machine Coexistence**	**Far Future: (Multi-planetary) Machine Society**
Machine Type	"Dumb"	"Connected"	"Smart & Connected"	"Independent"	"Singularity"
Purpose	Serve Humans	Serve Humans, Self-Improvement	Serve Humans and Other Machines	Serve Humans by Serving Itself	Serve Itself
Task Type	Simple, Repetitive	Sophisticated, Responsive	Autonomous	Self-Responsible (Independent Agents)	Self-Sustaining
Needs (to reach next stage)	Physiological: Energy, Infrastructure, Computing Power, Connectivity	Safety & Security: Reliable Infrastructure, Cryptographic Ciphers, Defense Mechanisms	Social Belonging: Machine Identity & Ownership, Machine Collaboration & Relationships, Data Privacy	Self-Esteem: Attention and Reputation Systems, Cognitive Capabilities	Self-Actualization: Machine Consciousness, Artificial Feelings, Creativity, Ethics
Example	Calculator	iPhone w/ Siri	Autonomous Car	Self-Owned Car	Decentralized Autonomous Organization

*Singularity: Surpassing humans knowledge (to serve the greater good): Self-definition of goals and tasks through self-learning and self-improvement cycles, "humanization of machine" : creativity, emotions, original thinking

Success in this new world requires understanding the unique needs of machines (and the algorithms that drive them), building the technology and skills to enable machine to machine interactions and the regulatory and legal foundations to support it all.

We invite you to **join us** in shaping the processes, technologies and thinking that will allow us to drive the most benefit from the emerging, machine centered world, and to **learn more** about these and other innovation thinking. ■

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About innogy SE

innogy SE is Germany's leading energy company, with revenue of around €44 billion (2016), more than 40,000 employees and activities in 16 countries across Europe. With its three business segments Grid & Infrastructure, Retail and Renewables, innogy addresses the requirements of a modern, decarbonised, decentralised and digital energy world. Its activities focus on its 23 million customers, and on offering them innovative and sustainable products and services which enable them to use energy more efficiently and improve their quality of life. www.innogy.com

About the innogy Innovation Hub

At the innogy Innovation Hub we are committed to drive gaming-changing ideas to evolve an innovation portfolio. Our purpose is to build, found or invest in new companies that have the potential of exponential growth in the future, with the innogy Innovation Hub as partner of choice. We focus on 'Machine Economy', 'Urban Exponentials', 'Smart & Connected', 'Disruptive Digital' and 'CyberSec Ventures'. In our innovation ecosystem in Silicon Valley, Tel Aviv, Berlin and London we are partnering with innovative start-ups to co-create new digital, platform-powered and data-driven business models.

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About Venture Idea

Venture Idea is a strategy consultancy specialized on efficient innovation in large companies. Through 6 years of intensive research, the company developed the 5C-process, enabling large companies to innovate within highly complex environments. Venture idea applied their method and thinking in more than 50 projects for companies such as DHL, Vodafone, innogy, or adidas. www.venture-idea.com/english