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Shaping the Fourth Industrial Revolution

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require standards across multiple applications – standards that presently do not exist.

Distributed ledgers can also have environmental externalities. The most common way that a blockchain achieves its goal of immutability is known as "proof-of-work", where network participants compete by expending large amounts of computing effort, and therefore energy, to securely validate transactions in return for the possibility of a reward. Under this model, employed by both the bitcoin and Ethereum cryptocurrencies, more transactions mean more energy is needed to verify them and the greater the environmental impact – another example of a not-so-hidden transaction cost in a Fourth Industrial Revolution technology.[95]

There is also the fact that secure, anonymous, programmable networks could lower the cost of criminal activity. The same protocols that allow for smart contracts to protect the interests of individuals through encryption also allow consortiums to perform illicit activities, such as illegal drug trading, human trafficking, fraud, and more.[96] Another issue is the accessibility of the technology itself. While bitcoin "wallets" are becoming easier to access and use, few mass or widespread incentives exist for individuals and organizations to accept the switching costs of moving to blockchain-enabled platforms. The lack of abundant platforms and intuitive applications, though they are not far away, poses another barrier.

A Technology for Trust

By Carsten Stöcker, Head, Blockchain Competence Team, innogy, Germany, and Burkhard Blechschmidt, Head, CIO Advisory, Cognizant, Germany

Historically, trust was added on to products or transactions as they flowed through the manufacturing supply chain. Physical, or electronic, records trailed every object to prove its origin, destination, quantity and history. Producing, tracking and verifying all this information imposes a massive "trust tax" of time and effort on banks, accountants, lawyers, auditors and quality inspectors. Important information could be lost, inaccessible or even intentionally hidden.

As the Fourth Industrial Revolution unfolds, blurring the line between the physical and digital worlds, blockchain is emerging to allow digital product memories to follow physical objects and guide them through the entire supply chain. When combined with cryptographically secure tagging, blockchain will create truly unique IDs and immutable records to make it easier and less expensive for suppliers and customers to transact with one another in a verifiable way.

Blockchain-enabled "distributed trust" will drive entire new manufacturing business models such as:

- Secure marketplaces for designers to publish, and be paid for, their work in the form of protected manufacturing design files
- Marketplaces of digital product memories enabling manufacturers to reduce the cost of quality control, regulatory compliance, warranty or recall actions
- Data services using blockchains to sell data-driven insights in areas such as product design, marketing, supply-chain orchestration or manufacturing
- "Asset-less" enterprises that rely on third-party manufacturers, verifying their work with blockchain-enabled transparent and credible supply-chain data

Potential winners in this new world include:

- Product and service providers in geographies with weak rule of law and intellectual property, as blockchains make it easier to protect their data and financial transactions even in the absence of strong governmental institutions
- Smaller product designers, raw material suppliers and service providers that would otherwise find it too expensive or time-consuming to ensure trust with larger, geographically dispersed counterparties
- Aggregators and sellers of blockchain-protected data on manufacturing or operations that can help maximize the value of products produced within blockchain value chains
- Service providers for decentralized autonomous manufacturing organizations enabled by blockchain; such services could include robotic manufacturing, shipping and financing
- Micromanufacturers specializing in high value make-to-order products

Potential losers include:

- Any supply-chain player with higher hidden costs and inefficiencies or lower quality whose traditional, cumbersome, opaque trust mechanisms can be replaced by blockchain
- Intermediary business service providers that provide "matching" or "marketplace" services, such as e-commerce aggregators
- Lower-skilled workers, both on the assembly line and in supporting clerical jobs, as blockchain and new technologies such as 3D printing and advanced robotics automate the routine assembly and tracking of products and contracts
- Higher-skilled workers, such as vendor managers, accountants, warranty managers and lawyers, as blockchain technology automates complex negotiations, tracking and verification processes
- Financial, auditing and related institutions, as payment, risk management and quality assurance move to the blockchain

As a consequence, the intersection of blockchain-enabled distributed trust with a variety of Fourth Industrial Revolution technologies will radically transform entire ecosystems.

Early blockchain adopters face challenges with this still-evolving technology in areas such as systems integration, business cases, standards and regulatory compliance. Many are developing cross-industry partnerships and actively building ecosystems while demonstrating "applied ecosystem leadership" to inform cost-effective, low-risk innovation.

The permanent and transparent nature of blockchain records means they would be well-suited to creating secure digital identities, potentially revolutionizing everything from healthcare records to voting and the delivery of government services. But, as argues Catherine Mulligan, Co-Director, Centre for Cryptocurrency Research and Engineering, Imperial College London, we should pause to consider the risks before rushing in this direction: the information in an undeniable ledger could be grossly misused by a malevolent government with access to private keys.[97]

Perhaps most challenging, conceptually, is the loss of central authority. This challenge is more than institutional. It is deeply psychological and attached to systems of human order. Decentralizing trust by relying on a complex set of algorithms is as radical as the shift from human deduction as the ultimate source of knowledge to reliance