THE ROLE OF BUSINESS INTELLIGENCE IN THE AGE OF THE FOURTH INDUSTRIAL REVOLUTION

Author:

Patrick Schneider

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ABSTRACT

The fourth industrial revolution is currently taking place and is expected to change the life in our society and alter the way we work or relate to one another.

In this essay, we take a closer look on the upcoming 4th industrial revolution, and the role of business intelligence in the field of industry 4.0. For the application of data science, we have to understand our application environment and its future changes. Due to disruptive changes, companies are faced with the difficult challenges to adapt quickly, in order to keep a competitive advantage. The following text should give data scientist an idea of what we can expect of our future work and business environment in the Industry 4.0.

"The Fourth Industrial Revolution is still in its nascent state. But with the swift pace of change and disruption to business and society, the time to join in is now."

Gary Coleman, Global Industry and Senior Client Advisor, Deloitte Consulting

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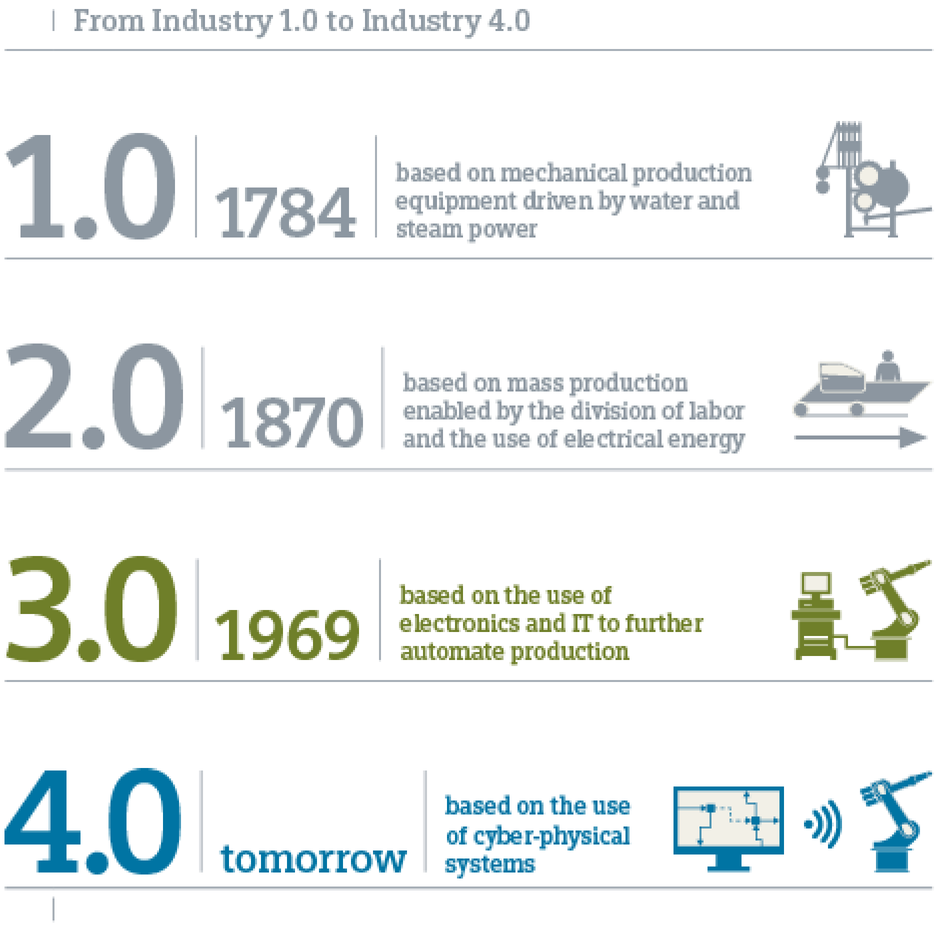
1. WHAT IS THE 4TH INDUSTRIAL REVOLUTION?

And the beginning came the steam and water power; followed by electricity and assembly lines; then computerization; and now we face the new era with the name of 4th Industrial Revolution (or Industry 4.0 and Internet of Things). The 4th IR represents the combination of physical- and cyber-systems, the Internet of Things and the Internet of Systems. These combinations of new technologies will impact all disciplines, economies and industries. [1]



1 Stages of Industrial Evolution [12]

Following is an overview of notable characteristics of the change on a customer and business perspective:

Customer perspective:

- Virtual reality that allows us to explore new worlds to new worlds or consume and interact with information in new ways.
- Advanced robots and software working side-by-side with humans.
- Nano-bots that could one day be injected into the human blood stream to cure an illness.
- Voice smart home controlling.
- 3D printing tools and limbs.
- Artificial intelligence used to help diagnose a patient or law case.

Business perspective:

- Many companies are developing much faster as in the way business has been traditionally done (e.g. Uber, AirBnB, Paypal, Facebook, Alibaba, Amazon, Google and many more)
- Big Data, Data Analytics lead to Data as a new currency
- Established companies are having difficulties adjusting to the speed and depth of changes in the market and have to find other ways to innovate much faster.

The Internet of Things, as the main component of the 4^{th} IR, has an immense potential to connect billions of people and devices to the web, improve efficiency of businesses and organizations, as well as give nature something back through better asset management, that the other industrial revolution have taken for granted.

In the following table are the top incoming changes that decision maker in the information and communications technology sector are expecting to occur by 2025:

Shift	Description	%
Wearable Internet	10% of people wearing clothes connected to the internet	91.2
The Internet of and for Things	1 trillion sensors connected to the internet	89.2
Smart Cities	The first city with more than 50,000 people and no traffic lights	63.7
Big Data for Decisions	The first government to replace its census with big-data sources	82.9
Driverless Cars	Driverless cars equaling 10% of all cars on US roads	78.2
Artificial Intelligence and Decision-Making	The first AI machine on a corporate board of directors	45.2
AI and White-Collar Jobs	30% of corporate audits performed by AI	75.4
Robotics and Services	The first robotic pharmacist in the US	86.5
Bitcoin and the Blockchain	10% of global gross domestic product stored on blockchain technology	57.9
…	…	…

2 ICT expected tipping points by 2025 [2]

As seen in the results of the survey conducted by WEF that IoT, Big Data, AI, Data Mining and Block chain were among the main fields that will significantly affect our lives. From this it can be deduced that data fusion and analytics will have a critical role in the transfer to the new era of the 4th IR.

Due to this big paradigm shift that affects life in nearly every aspect, I want to focus in this essay on the field of the Industry 4.0 and its *Smart-Factories*.

In the core of this new era are human interaction in cooperation with the fields of information exchange, automation and manufacturing technologies. The current economy and society and manufacturing industries will be transformed using artificial intelligence (AI), IoT, robotics, autonomous vehicles, 3D printing, nanotechnology, materials science, biotechnology and energy storage.

Companies will see new opportunities in sustainable industrial manufacturing, to produce customized and small scale products especially for its consumers need.

The fourth revolution won't center on machinery that's simply stronger and faster: It will wrap around machines that process, share, and act upon information without human input, fundamentally modifying our relationships to our tools, our world, and one another.

2. DATA AND THE 4TH INDUSTRIAL REVOLUTION

Not coal, steel, or silicon —Data will be the fuel and currency of the new revolution.

Analytics needs two things: the data used to fuel the analysis and the implementation of the learnings of the analysis back into the business processes. In this section, the focus will be held on the data.

Data is the core element of the 4th IR and gives us an insight in machines, people, finance, products, risks, material, equipment's and operations. Since data became a critical source for innovation and development, companies that automate and mine the big amounts of generated data were getting a competitive lead.

With new industrial automation equipment increasingly integrating sensors and wireless communications capabilities, factories are gaining the capability to gather sufficient processes and material data. With an expected price drop to 0.38$ each sensor till 2020, the information gathering will get more affordable for even the smallest elements, that fuels the Internet of Things. [3] The more information are gathered, saved and analyzed, the more detailed the image gets of how a small elements influence on a big system.

With the hype about big data, the big information gathering already started. IoT in combination with Industry 4.0 will strengthen this trend. An International Data Corporation (IDC) report predicts that ‘‘from 2005 to 2020, the digital universe will grow by a factor of 300, from 130 Exabyte to 40 000 Exabyte’’ and that ‘‘from now until 2020 will about double every two years.’’ [4]

But with collecting data only, it is not done. IBM describes Big data with the characteristics as shown and explained in the following picture:

3 The 4 V of Big Data (Value not inclued) [5]

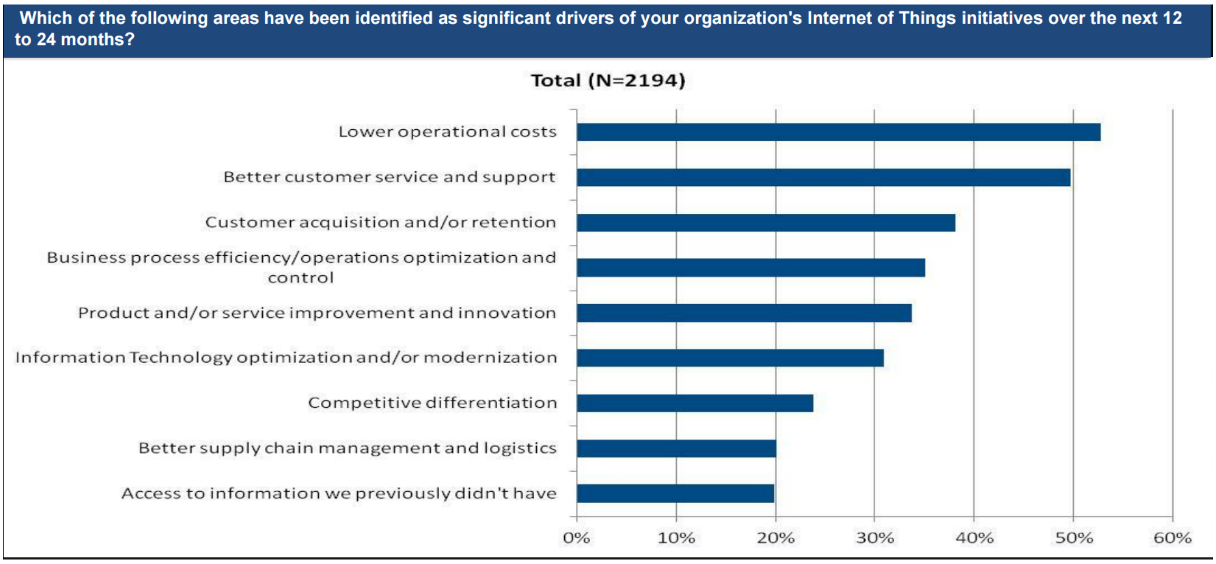
The collection, storage, processing and analysis will offer big challenges in the transfer to the new 4th IR. All those characteristics of data contain a science on its own and will be put into context with the Industry 4.0 in section 4

3. BENEFIT TROUGH BUSINESS INTELLIGENCE IN THE 4TH IR

"Information is the oil of the 21st century, and analytics is the combustion engine” (Peter Sondergaard, Senior Vice President, Gartner)

At this point we have to question our self: We now have the data, but what can we do with it in the 4th IR?

With the help of analytical systems, the transformation from big data to smart data can be achieved, from which new products, services and insights are created Manufacturers have high expectations for the 4th IR, to lower their costs, increase customer satisfaction, customer acquisition or retention, minimize waste, increase margins, guide product and service innovation many more, as illustrated in the following figure:



4 Significant drivers for organizational Internet of Things initiatives [6]

The major paradigm change will take place in two concepts: [7]

a) Concept: Event triggered control systems

Nowadays manufacturing companies mostly produce with a planned time triggered system. The company plans the production based on demand signals. These information are controlled in the enterprise resource planning system, which is tied to the manufacturing execution system. The materials are planned in the supply chain and products delivered through the distribution channels. The value creation process is in this sense deterministic, without randomness. Events like moving materials to a production machine, are based on time triggers. Along the value chain of a product, a lot of different measurements are done, but e.g. the sampling is still triggered at a predetermined time. This deterministic approach is designed to be predictable and stable.

The **future** smart factory only produces a product based on the demand. In addition to this, an operation is only performed when a data signal is present. This leads us to the paradigm shift of the event triggered control.

In this paradigm, the factory performs to events when they happen. Products can be configured individually of the consumer's demand. Another example could be an unplanned outage of a machine. This can interrupt the right production sequence. A part carrier can be automatically informed about the outage, that leads to a dynamical reorganization with different machines to find the best production steps. This can make the manufacturing more efficient, adaptive and minimize activities as well as materials in occurrence of unplanned events.

A lot of data collection and communication between the machines needs to takes place to fulfill the requirements of this paradigm shift. The expected reality will probably be a combination of time triggered and event triggered control systems.

b) Concept: Data sharing in form of unified data model.

In this shift, the data model of data exchange will get closer to data sharing. With the computerization of factories, IT system domains where established like ERP systems, engineering analysis, computer aided design and simulation programs and robotic manufacturing systems. Over the last decades, most investments have been placed to single point solutions for these domains. The solution are mostly based on the paradigm of a transaction oriented enterprise resource planning system. Due to the independent development of those system in a heterogenous IT environment, the systems mostly weren't designed to communicate by standard with each other. Nevertheless, the possibilities of exporting data from one into the other system was available. But changes to the distributed data were often not moved to the origin data store.

An example: A possible goal will be in case of quality defects to directly report it to the design, to enable quick adaptions, including the material order and the automated design. The basis for this would be shared data in an integrated data model with every participant in the relevant section of the process and value chain (called: single source of truth). Pioneers in this field use integrated product lifecycle management tools to achieve this goal. A change in the process becomes transparent and accessible to everyone.

c) Future techniques in smart companies

Mentionable technics for the future smart companies will be robotics and artificial intelligence, once it is considered safe to run autonomously. Manufacturing processes will be more and more controlled by expert systems, autonomous devices and digital assistants. The focus will be set on how workers work together with machines in one synergy.

4. CHALLENGES

The 4th IR demands a new way of thinking about individuals, system concepts and organization management.

IT system infrastructure

Shared data in form of a global source of truth. Mentioned in the section 3 of the paradigm shift.

Event triggered control systems that require cross-domain knowledge and a highly-integrated IT system infrastructure. Mentioned in the section 3 of the paradigm shift.

Data driven process monitoring/prognostics and system control and optimization is still a topic that must be improved in the industrial sector. A good example can be found in the finance sector, where fraud detection is implemented in form of an artificial intelligence algorithm, where the analysis is not done by a human anymore. Due to the confidential treatment of information in enterprises, academic research facilities are hindered in developing new approaches and techniques. With a greater enterprise and research cooperation, new ideas and new technics can be developed for the whole industry.

Big Data [9]

The known challenges of the big data trend are still present and will even become intensified. Industrial big data faces still the problem of data measurement, detection and processing.

By observing the behavior of many things, the vision faces the Big Data's V-challenges: [8]

- store all the events (Velocity & Volume Challenge)
- run analytical queries over the stored events; (Velocity & Volume Challenge)
- perform analytics (data mining and machine learning) over the data to gain insights (Velocity & Volume & Variety Challenge)

Volume and variety: Huge volume and the limitless variety of big data creates complex requirements for hardware and software to deal with data. To mention is that Cloud-technologies still need improvements to cope with the requirements of real-time applications in the complex smart manufacturing industry.

Veracity and velocity: Data has to be processed properly and in time, before any possible corruption or manipulations. Data obtained from original sources must be preprocessed or filtered before real application can process them. The larger the volumes get, the more difficult it becomes to prepare the data properly in time. This means the collected data from processes and systems should be timely detected. Although not necessarily the large volume is the problem, but the online processing ability. It is currently the limiting factor in the velocity of industrial applications.

Value: To create smart data, interdisciplinary cooperation is needed, that raises the most difficult issues for industrial big data usage. It must be validated that the data is reliable, useful and accurate and in the end, extract the value out of it. To create this value, data based methods and algorithm have to create the value with the help of statistical analysis in business, management and operation.

Streaming [9]

Velocity: How to process streaming events on the fly and how to store streaming events in the operational database

Volume (& Velocity): How to correlate this streaming events with the already stored data in operational databases

Business Intelligence – Infrastructure

Based on the other challenges, following processing paradigm will find its need in the different transaction, analysis and processing domains. For streaming with stored data correlation, the delivery platforms will need a move from scalable SQL/NoSQL to scalable complex event processing. The update operational databases require scalable complex event processing with scalable OLTP processing. The performance of analytics on operational databases needs the change to scalable OLAP and OLTP processing. [9]

5. EXAMPLE OF MODERN SMART COMPANIES

The smart company of the future can be already found in the industry.

a) Siemens Electronic Works

In the Siemens factory in Amberg, Products can find autonomously their way through the production process. The result is an individualized, resource-friendly and highly adaptive mass production. Its smart machines coordinate the production and global distribution of the company's Simatic control devices. [9]

Main characteristics:

- a custom, built-to-order process involving more than 1.6 billion components
- sources about 10,000 materials from 250 suppliers to make the plant's 950 different products (over 50,000 annual product variations).

Quality statistics according to Gartner Industry Research:

- Records about 11 defects per million
- 99.9989 % reliability rate
- 100% traceability on its expansive lines

5Siemens Electronic works Amberg

The endless variables and complex supply chain this production process requires, exceed the capabilities of a traditional factory. Just like organizing its material flow, sequencing its processes or even intelligently scheduling its 1,100 employees to meet the requirements of an ever-changing job is beyond the capabilities of any human, single technology or any single tool.

There products and machines communicate with each other, to enable the products themselves to control their production.

One result is that in the same amount of production space and with a workforce that has changed only slightly in number, the plant has increased its production volume eight times in the past 20 years.

b) Volkswagen AG

The increasing complexity of electronics in cars is accelerating the Industry 4.0 concept in Volkswagen AG.

Volkswagen follows a RFID strategy that establishes a traceable supply chain with its suppliers and the factory. They are essential if suppliers and automotive manufacturers are to establish a traceable supply chain. The main application fields are in tracing vehicle, reusable containers and prototype parts. Those parts can be identified at any time from the manufacturing, over to the sales, till the customer. RFID transponder can be associated to a customer by entering a car workshop.

Component containers are tracked from incoming materials to warehousing, over to production, while RFID gates and hand-held scanners take the job of tracing all parts. This is necessary when developing prototypes, were in Volkswagen over 4,000 experimental cars are equipped with transponders. As the cars need to be modified all the time, the individual parts are constantly in motion as they pass through various experimental cars and environments. VW can check at any time, which part is in which vehicle.

Over 235 VW suppliers are currently involved and implement RFID transponders to their products. Volkswagen provides the software and plans to increase the figure to 400 suppliers by the end of 2016.

6. CONCLUSSION

When the 4^{th} industrial revolution finally takes place, it will probably create a mass extinction, that only the companies with a good vision can survive. The full potential of the 4^{th} Industrial Revolution will be felt when intelligent devices, intelligent systems and intelligent automation are fully consolidated with the physical machines, facilities, fleets and networks along the value chain. Due to the core requirement of smart data in the 4^{th} industrial revolution, it is a good time to be a data scientist.

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