8-2019

Industry 4.0: Ethical and moral predicaments

W. WANG

Keng SIAU
Singapore Management University, klsiau@smu.edu.sg

A GOOD MORAL COMPASS

Industry 4.0: Ethical and Moral Predicaments

by Weiyu Wang and Keng Siau

The advancements in software technology and data science are enabling Industry 4.0, aka the Fourth Industrial Revolution or the Industrial Internet of Things (IIoT). While the first three industrial revolutions have brought about immense change, the impact of Industry 4.0 will be much wider and far greater, especially with regard to the easily overlooked ethical and moral aspects. Widening wealth gaps between countries and among classes of people within countries, a potential growing unemployment rate, data privacy and accessibility issues, and the treatment of intelligent agents (e.g., military robots) present new and complex ethical and moral dilemmas.

In this article, we discuss Industry 4.0 ethical and moral predicaments from the perspective of different business and technical forces. We present ethical and moral issues related to data privacy, data ownership, system accessibility, cybersecurity, the future of work, and the future of humanity. Our aim is to present various challenges and discuss ethical and moral considerations from different perspectives. We hope this discussion will give business executives and technical designers/developers a better understanding and appreciation of the ethical and moral challenges Industry 4.0 presents.

> *Industry 4.0's opportunities and benefits can be seen in more efficiently used resources, more personalized customer service, and easier-to-use and more cost-efficient upgraded equipment.*

Industry 4.0

Industry 4.0 collectively refers to a wide range of concepts, including cyber-physical systems (CPSs), the Internet of Things (IoT), artificial intelligence (AI), cloud computing, smart manufacturing, decentralized self-organization, and advanced analysis techniques. It focuses primarily on the establishment of smart factories, smart products, and smart services embedded in the IoT and the conversion of established factories into smart manufacturing environments. Industry 4.0 allows for continuous interaction and information exchange among humans (consumers), between humans and machines, and between the machines themselves.

In 2013, Morgan Stanley predicted that more than 75 billion objects will connect to the IoT by 2020.[1] New, flexible business models that enable personalized and digital products and services will need large amounts of high-quality data in the near future. Highly automated and even autonomous machine tools and robots will be widely available. By 2025, the rate of automation (division of labor as share of hours spent) will be 52%,[2] a sharp contrast to the 2018 rate of 29%. Indeed, unless there's a creation of new industries not yet present, the number of workers will likely decrease. New and remaining jobs may require more knowledge than current ones and may also demand new skill sets. This will necessitate retraining and retooling of existing workers. Consequently, the education paradigm will have to be reengineered. Also, with Industry 4.0, the organization will be more decentralized rather than centralized, which not only leads to management complexity but also challenges existing management theories and practices.

Industry 4.0's opportunities and benefits can be seen in more efficiently used resources, more personalized customer service, and easier-to-use and more cost-efficient upgraded equipment. More intelligent agents in CPSs will release humans from laborious tasks, allowing people to dedicate time to more meaningful work. However, we cannot overlook the challenges and risks Industry 4.0 presents. The main challenges revolve around technological, organizational, strategic, legal, and ethical and moral issues. Our focus here is on the ethical and moral issues that have thus far received little attention.

Ethics

Ethics is a complex, complicated, and convoluted concept, which we will not attempt to define in detail in
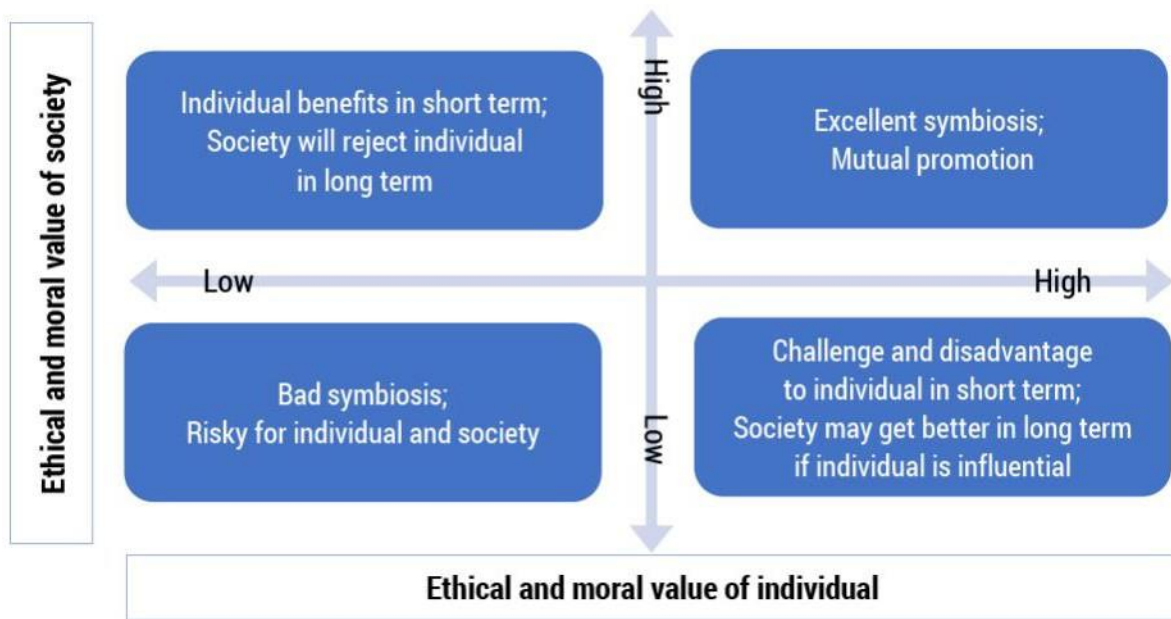
Figure 1 — Symbiosis of society and individual (ethical and moral values).

this article. Briefly, ethics refers to the moral principles that govern behavior, and the study of ethics involves what constitutes ideal conduct in various situations.

Ethics affect both individuals and society as a whole, as illustrated in Figure 1. A highly ethical society and a highly ethical individual can mutually promote ethics, establishing a good symbiosis. In a society with high ethical values, an individual with low ethical values may benefit in the short term, but in the long term, society will reject that individual. If the individual has high ethical values but the society has low ethical values, it will be challenging for the individual to survive in this society; if the individual is influential, the societal ethics may improve over the long term. The worst situation is when both society and the individual have low ethical values.

To study ethical issues is to examine the moral aspects of conduct and the actions deemed "morally accepta-ble." Table 1 provides an overview of some established ethical frameworks. The framework examples provide background knowledge to aid in understanding ethical issues. Some scholars believe that classic ethical princ-iples can and should be used to deal with new technol-ogy, which, as an example, should not bring any harm to users. Others argue that new dimensions of ethical issues, such as the responsibility of machines, should be considered and included in the discussion. For instance, the involvement of intelligent agents in manufacturing enables some tasks to proceed without human partici-pation. But if an agent makes the wrong decision and causes severe damage (e.g., kills somebody), is the

agent solely responsible? What about the designers and builders of the agent? In the next few sections, we will analyze potential ethical issues in Industry 4.0 from different perspectives.

Ethical and Moral Forces in Industry 4.0

The ethical forces of Industry 4.0 exert their influence over different stages in value chain activities — from design, development, and production to application. Tracing the ethical responsibility and decision making of each stakeholder associated with value chain activ-ities is very important and poses a major challenge. AI and autonomous systems make the tracing of ethical responsibility more pressing because some of those functions may be performed without human inter-vention. A lack of ethical and moral standards in those autonomous agents and decision-making software is a problem, and a lack of experience and guidance in formulating ethical and moral standards in Industry 4.0 exacerbate the problem.

In general, the difference between Industry 4.0 and previous industrialization comes from the wide application of CPSs, which connect the physical and virtual worlds and realize real-time information interaction among different stakeholders. In past industrial revolutions, technology supplemented and replaced the limited physical strength and speed of humans. In Industry 4.0, advanced technology can supplement and replace humans' limited cognitive processing space/scope, along with speed. This is at

Reference	Ethical Framework
"The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research." US Department of Health, Education, and Welfare. Publication No. (OS) 78-0014, 18 April 1979.	**Ethical principles:** respect for subject (the right to decide whether to participate); beneficence (do no harm to participants); and justice (fairly distribute costs and benefits of research)
Mason, Richard O. "Four Ethical Issues of the Information Age." *MIS Quarterly*, March 1986.	**PAPA issues:** privacy, accuracy, property, and accessibility
Bentham, Jeremy. *The Collected Works of Jeremy Bentham: An Introduction to the Principles of Morals and Legislation*. Clarendon Press, 1996.	**Act utilitarianism:** tally the consequences of each action first and then determine on a case-by-case basis whether an action is morally right or wrong; **hedonistic utilitarianism:** pleasure and pain are the only consequences that matter in determining whether the conduct is moral or not
Wallach, Hanna. "Big Data, Machine Learning, and the Social Sciences: Fairness, Accountability, and Transparency." Medium, 19 December 2014.	**Ethical principles:** fairness (bias, fairness, and inclusion), accountability, and transparency
Sinnott-Armstrong, Walter. "Consequentialism." In *The Stanford Encyclopedia of Philosophy*, edited by Edward N. Zalta. Stanford University, Summer 2019.	**Consequentialism:** engaging in action that causes more good than harm
Hursthouse, Rosalind, and Glen Pettigrove. "Virtue Ethics." In *The Stanford Encyclopedia of Philosophy*, edited by Edward N. Zalta. Stanford University, Winter 2018.	**Virtue ethics:** having ethical thoughts and ethical character
Alexander, Larry, and Michael Moore. "Deontological Ethics." In *The Stanford Encyclopedia of Philosophy*, edited by Edward N. Zalta. Stanford University, Winter 2016.	**Deontological ethics:** conforming to rules, laws, and other statements of ethical duty (e.g., religious texts, industry codes of ethics, and laws)

Table 1 — Examples of ethical frameworks.

the same time both exciting and frightening. Humans are not the strongest in the animal kingdom, but our cognitive superiority has enabled our dominance as a species on this planet. If our cognitive superiority is challenged, the future of humanity is uncertain.

We use "force" to describe any agent that may interact with CPSs and can take responsibility (or be responsible). Based on the roles each force plays, we classify the forces into two groups: (1) technical-oriented and (2) business-oriented. Figure 2 shows the forces and the interactions and communication among them, which is the collective responsibility of the business- and technical-oriented forces. Next, we discuss the responsibilities of the various forces in promoting an Industry 4.0 that subscribes to high ethical and moral values.

Business-Oriented Forces

In today's competitive business environment, ethical issues arise frequently. Business partners may not

respect contracts, or competitors may attempt to steal business secrets. With Industry 4.0, the situation becomes much more complex. Consider the trend to personalized production, which benefits individuals who receive personalized services. Achieving personalized services, however, involves big data, data science, AI, machine learning (ML), and automation. This raises complex organizational and social issues. For example, the adoption of more autonomous systems and automation will likely lower the employment rate, hurting human motivation, well-being, and livelihoods. Let's further explore these issues.

Shareholders and Business Executives

Business executives typically act in the interest of shareholders and for the purpose of maximizing shareholder value. In accordance with this belief in the predominance of shareholder value, business executives would replace employees with automation if that seemed to be in the best interest of the sharehold-

Figure 2 — Ethical and moral forces of Industry 4.0.

ers. Walmart, among many other retailers, has added robots to its stores to scan shelves, unload boxes, and mop up floors in an effort to reduce costs. In addition to the loss of jobs, automation may decrease human contact and interaction, weakening human relationships in the workplace. Profit maximization may also result in ignoring or downplaying security and safety considerations, such as employee safety, data security, and customer privacy. Business executives should ensure that sufficient resources and efforts are expended to establish a safe culture in the company, with, for example, employee safety training and data security education.

Employees

In the new business models, intelligent agents and autonomous systems will affect employment. Laborious and repetitive jobs will be restructured or even eliminated. The structure of the jobs that remain may also change significantly. New jobs may be created, but specialized knowledge and more complex skill sets will likely be needed. To adapt to the new working environment, major transformation in education as well as on-the-job retraining will be necessary.

The main concern is those groups of workers who will be left behind by Industry 4.0. To face the possibility of technological unemployment in an ethical manner, some people have suggested a universal basic income (UBI).[3] On the bright side, people can survive with a UBI. On the other hand, how can people realize their

esteem and self-actualization needs, which usually come from accomplishments in their works or jobs? Social fairness would be another ethical concern with a UBI: why should all individuals receive the same UBI? For example, some individuals will be more highly educated, and some individuals may be in ill health and require more financial support.

Customers/Clients

Personalization or customization has a long history and has long been desired by customers. In the early 20th century, for example, a trend that favored the wearing of bird feathers, beaks, and even bodies on hats pushed several species almost to extinction. With Industry 4.0, personalized products and services will be more accessible to the masses and more widespread. Customers' peculiar preferences and requests can be integrated into the design/development/production of the product. However, if customers are not well educated on the impact of their requirements and wishes, blindly meeting their demands may also lead to issues. For instance, a customer's desire to have a smartphone that can analyze the personality of a caller may lead to privacy and ethical issues. In that case, should this smartphone be produced?

Society

The social contract theory places responsibility on business executives to consider the needs of the society

in which a corporation is embedded. Social contract theorists ask what conditions would have to be met for the members of a society to agree to allow a corporation to be formed. In other words, society bestows legal recognition on a corporation to allow it to utilize social resources toward some given end. Under the social contract theory, a society may not want a corporation to continue to function if the corporation is replacing employees with automation and forcing society members into unemployment. Labor unions may demand to dialogue with industry and government for job adjustments for remaining or new employees (e.g., the establishment of workload policies) to protect the rights of those workers. Local communities also play an important role in protecting local jobs and the environment. Government should ensure that industries take responsibility on major social and labor issues in tripartite social agreements (among employer organizations, trade unions, and the government). It is noteworthy that some communities and organizations (e.g., AI Global, the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, and the Open Roboethics Institute) are dedicated to addressing ethical and moral issues in these areas.

Technical-Oriented Forces

The responsibility of each technical force stakeholder should be clear and transparent. Each stakeholder must maintain the highest ethical standards to prevent risky behaviors and harmful consequences. For instance, the failure of safety-critical systems may lead to loss of human life and other catastrophic consequences.

Designers and Developers

It is important that designers and developers know the ethical implications of the high-tech products or services that they design and build. The rapid development of computing technology, however, has resulted in policy vacuums. When different technologies from different companies are coupled or integrated, it can be difficult to assign responsibility. For example, if a self-driving car has an accident, who is responsible? Ambiguous responsibility may weaken the designers' sense of responsibility, but it is very important that all products are designed to be safe. Designers and developers should be held responsible for safety-related accidents that are a result of ignoring safety considerations in the design and development of new technology. The process of addressing ethical issues is a continuous

one; ethical policies associated with computing technology should evolve as technology advances. Although rapid advances in technology make it harder to study ethical issues and establish ethical standards and policies particular to a technology, general guidelines and policies can be developed as a basis for a framework for ethical assessment in Industry 4.0.

Users

Separating design error from users' decisions is also crucial. Users should be aware of the impact of their decisions. As an example, police officers (users) deploying autonomous drones to destroy drug plantations must assess the environmental impact (e.g., to avoid starting a forest fire). In addition, users should be well trained to work with CPSs and other intelligent agents; if not, users working with new artifacts and intelligent devices may be exposed to a potentially hazardous environment without a full understanding of the technology. New and unexpected behavior resulting from new technology will increase the risk of error and wrong decisions. Almost all computer and smart devices are now Internet- and social media–enabled. On the one hand, this provides convenience and accessibility for the users. On the other hand, this exposes many computers and devices to cyberattack because of user carelessness or unfamiliarity with cyberthreats. Many organizations currently have mandatory cybersecurity training, which was not required five or 10 years ago. Some high-security government agencies have even cut off access to the Internet in the workplace. In many cases, users are not fully aware of the interactions that take place in current smart environments, such as the IoT. This lack of user awareness can exacerbate the ethical and moral issues Industry 4.0 raises.

Intelligent Agents

Assigning responsibility to intelligent agents is contentious. Critics believe that designers and developers should take responsibility for the decisions of intelligent agents. However, AI and ML present new challenges. While designers and developers may build the base model, the system will continue to learn and evolve. During the learning and evolving process, the intelligent system may pick up bad examples and produce erroneous outcomes. Thus, some argue that intelligent systems may need to be assigned responsibility. Not assigning responsibility to intelligent agents may create

a hazardous policy and ethics vacuum with unforesee-able negative consequences. Furthermore, developers may be reluctant to develop advanced technology if they fear being assigned responsibility for the bad decisions intelligent agents make. Such reluctance would seriously hinder technological progress.

Collective Responsibility

Because multiple stakeholders rather than only one stakeholder will typically be involved in an action/behavior, organizations need to consider collective responsibility. Ethical behavior and safe operation require each stakeholder to interact responsibly with all other stakeholders. The hardest part of collective responsibility is communication and information integration. At times, some stakeholders may not want to disclose certain information, making it necessary to investigate the ethical aspects of communication, and establishing what information should be disclosed for ethical reasons without exposing business secrets.

Competition may induce another ethical risk. Industry 4.0 will generate strong output globally, as well as increased competition in the marketplace. To adapt to new technology, companies need to update their skills and knowledge, invest appropriately, and change their business processes. For small and medium-sized enterprises, it will be challenging to compete with the leaders in these areas. Major players in a market can monopolize a market, and the result is often higher

prices for consumers. Although antitrust is one of those academic business ethics topics that is usually left to the lawyers, some scholars have advocated that business schools should cover antitrust ethics. Furthermore, the ability to adopt and invest in new technology may create a division between companies that successfully adapt to Industry 4.0 and those that do not. Industry 4.0 may also enlarge the gap between developed and developing economies.

Business and technical forces have an impact on the ethical world. In Figure 3, we depict the possible interactions between them. Highly ethical business-oriented and technical-oriented forces can mutually promote ethical behaviors and moral values, which is excellent symbiosis. If only business-oriented forces have high ethical values, the new technology and systems may be risky to human life. For instance, if self-driving cars are not very well developed because of irresponsible developers, accidents with human casualties may occur. In this case, business forces may compel technical forces to behave ethically, through contracts and legal procedures. If only technical-oriented forces have high ethical values, corporations may compete with each other using unethical methods. As an example, people reveal a great deal of personal information on social media, via smart home systems, and in online shops. If that information is not adequately protected or is sold to third parties for financial gain, people may suffer financial losses and emotional harm. If all forces exhibit low ethical values,
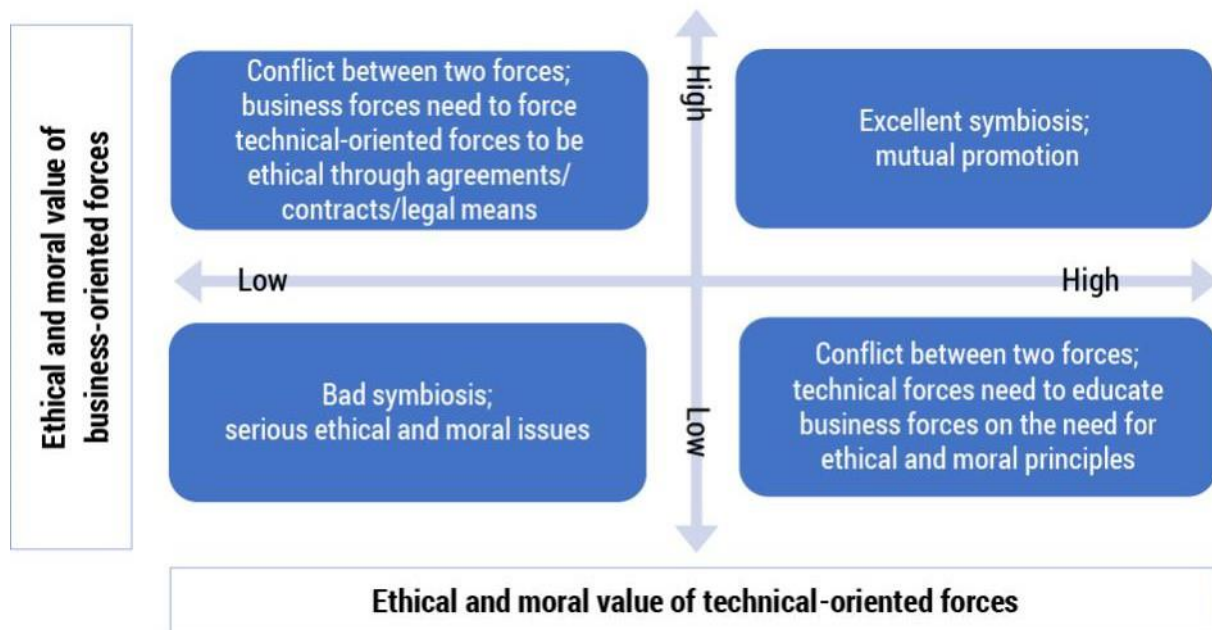

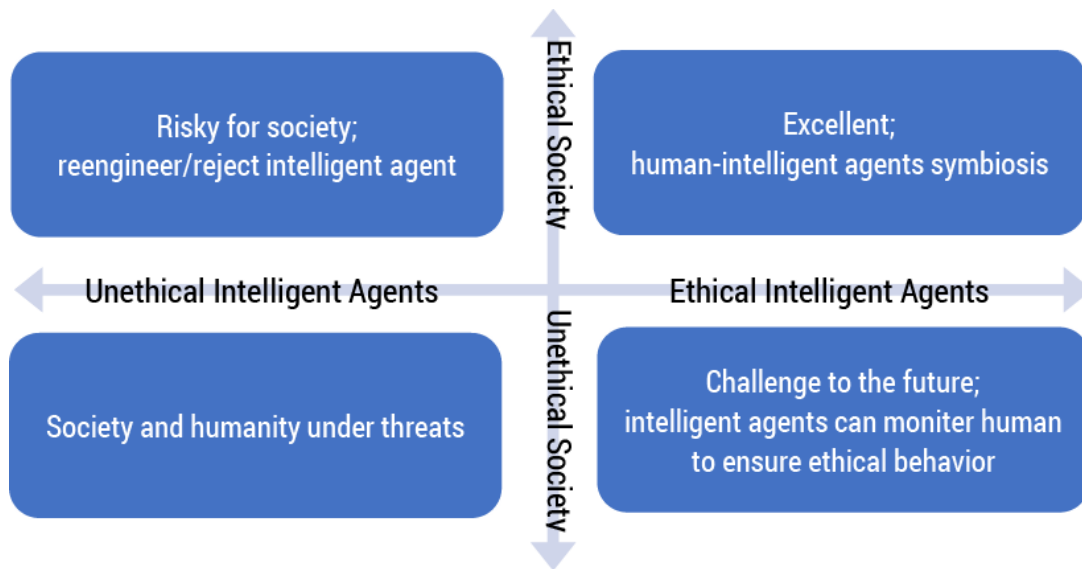Figure 3 — Symbiosis among ethical and moral forces of Industry 4.0.

Figure 4 — Symbiosis of human society and intelligent agents.

it would be a bad symbiosis, creating serious ethical and moral issues across society.

In addition to interactions between technical-oriented and business-oriented forces, we can examine the interaction of intelligent agents and human society. As shown in Figure 4, only when both human society and intelligent agents are highly ethical can we have healthy human-intelligent agent symbiosis. If only human society is ethical, humans should reengineer or even reject the intelligent agents. If only intelligent agents are ethical, unethical human society may pro-duce unethical agents, which is very risky for the future of humanity. However, developing and implementing ethical and moral intelligent agents can help to monitor humans to ensure ethical behavior. For instance, ethical intelligent agents would not comply with an unethical human command. If no party is ethical, society and humanity will be under great threat.

Ethical Framework in Industry 4.0

Data, new technology, and systems are crucial in Industry 4.0. Taking good advantage of them can benefit human society and enhance people's lives. However, it is very easy to overlook the potential ethical and moral impacts when using technology. In this section, we introduce the potential ethical issues in Industry 4.0. We look at them from two aspects: (1) ethical issues related to data and (2) ethical issues related to systems, technology products, and services. Figure 5 shows the basic framework of ethical issues in Industry 4.0.

Ethical Issues Related to Data

Data plays an important role in Industry 4.0. Data is collected from the human environment and analyzed to drive a new economy/new business models, increase profits, and improve services. Industry 4.0–related technology generates, stores, and uses highly sensitive data, which needs adequate security and privacy on a global scale. Ownership of the data needs to be clarified, too. It is challenging to formulate standards to encourage data sharing and yet provide appropriate protection.

Privacy and Data Security

There is always a tradeoff between creating smart services and maintaining privacy. For instance, to provide personalized customer service, as much knowledge about the person as possible should be collected. That, in turn, increases the risk to privacy. As evidenced by recent data breaches, information is increasingly exposed to hacking, resulting in infor-mation security and privacy issues. For example, data privacy is very important in the context of healthcare and social media, which involve sensitive private records. Indeed, the Facebook-Cambridge Analytica data scandal and many other data breaches expose the urgency of building a protection system for private data and information. Without clear ethical and moral guidelines and policies, management of collected personal information can be challenging. For example, all parties in an organization, business-oriented as well as technical-oriented, need to subscribe to the same ethical and moral standards. With proper ethical and
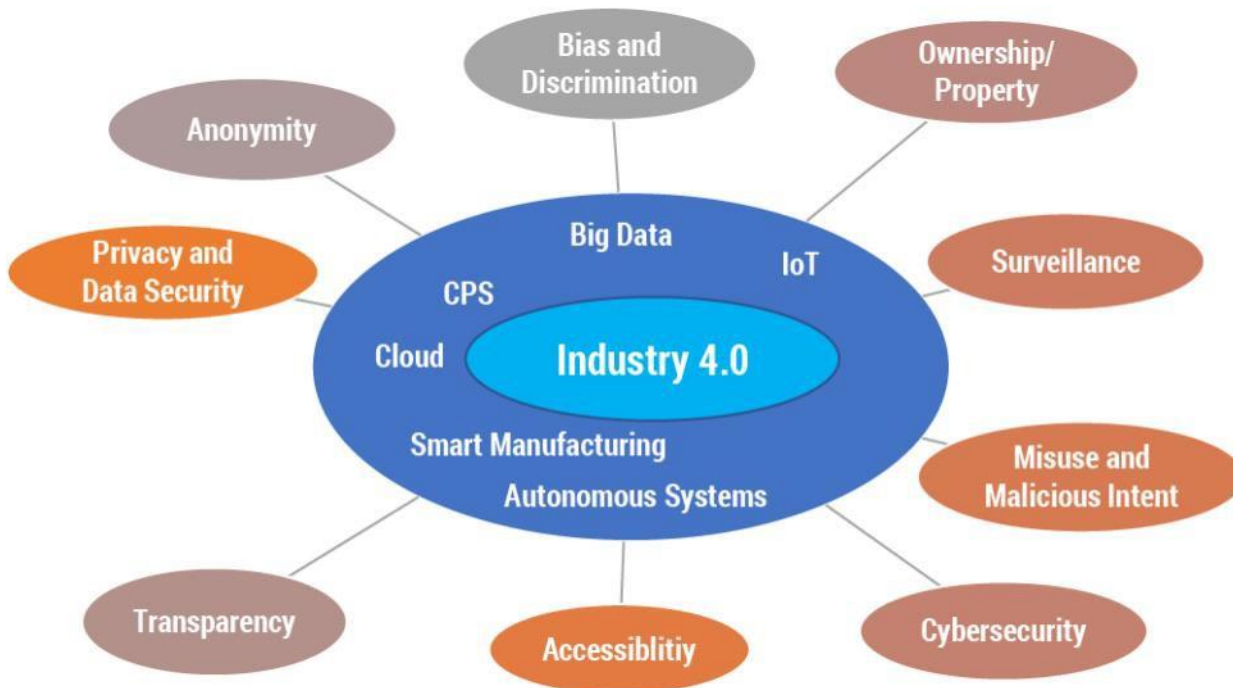
Figure 5 — Ethical framework in Industry 4.0.

moral education, we can reduce the number of hackers that explore a system's vulnerabilities and knowingly or unknowingly violate others' rights just for fun or for their own entertainment.

Anonymity

In the virtual world, people can use fake identities to remain anonymous. Anonymity, in itself, is neither unethical nor immoral. How anonymity is used, however, can create ethical and moral issues. For example, malicious attacks such as cyberbullying can be carried out anonymously. On the other hand, anonymity enables participants to generate more comments and contribute more ideas during anonymous brainstorming sessions. Studies have shown that de-anonymizing data is possible when the data in one data set is paired with that in other data sets.[4] Sensors in the environment, for example, can recognize real objects that people wear and use, and collaborating many data points together can have a de-anonymizing effect. All these technologies will result in the loss of anonymity in many cases. In Industry 4.0, there are more and more sensors available and more data collected about individuals. Recognizing when to provide anonymity and when to de-anonymize data requires ethical and moral judgments. Companies possessing such data must have clear ethical and moral guidelines on when to release

the data to any third party (including government agencies).

Bias and Discrimination

Many scholars have suggested bias and fairness as ethical principles.[5] Autonomous systems make decisions based on the data they can access, which raises concerns regarding bias and discrimination. ML uses existing data, some of which may be biased. One example of an ethical concern is that predictive insurance analytics may increase costs for, and therefore hinder, services to individuals prone to illness. In another example, Tay was an AI Twitter bot released by Microsoft in 2016. Tay, learning from its conversations with humans, became racist and tweeted many nasty utterances within a day and was eventually taken down. ML and autonomous systems will be widely available in Industry 4.0. Ensuring that autonomous systems maintain a high ethical and moral standard is a challenge.

Ownership/Property

IoT collects a lot of data about individuals. Correctly identifying data ownership and property is still an ongoing debate. Who owns the data collected by sensors connected to the IoT (e.g., Google Home or

Amazon Echo)? Data collected in the public domain may be arguably data owned by the collectors. What about data collected in one's home (e.g., what food is in the fridge)? What about data collected from one's surfing of the Internet using one's own computers? The IoT risks making the boundaries between public and private space invisible, creating privacy and ethical issues.

Surveillance

Another major concern is Big Brother–type surveillance, with people being monitored without their consent or even, in some cases, without being aware of being monitored. Smart assistants, such as Google Home and Amazon Echo, listen to their hosts all the time, waiting for a command. Having an assistant makes life easier, but if those assistants are misused, people are at risk of unauthorized surveillance, which is both an ethical and legal issue. Systems of protection from unauthorized remote intrusions should be elaborate and comprehensive. The legal systems need to catch up with the developments in Industry 4.0.

Misuse and Malicious Use

The amount of transferred data increases greatly in Industry 4.0. Big data comes from social media, online accounts, medical information, electronic communication, online searching, and many other sources. Among that data, inevitably, personal and private information, such as leisure time activities, medical conditions, or family information, will be disclosed. If the information is maliciously used or disclosed by some third party, negative consequences are possible. Again, this has ethical, moral, and legal implications.

Ethical Issues Related to Systems, Products, and Services

Accessibility

Accessibility, as an ethical principle, refers to whether systems, products, and services are suitable for all people, including the elderly, the handicapped, and the disabled.[6] Considering the complexity of new technology and high-tech products, as well as the aging populations of some countries, the accessibility of new technology will directly affect human well-being. The purpose of developing technology is to benefit humans. But if only a portion of people benefit, is it ethical and fair? Consideration must be given to developing

systems, products, and services that are accessible to all, and the benefits of advanced technology should be fairly distributed to all.

Transparency

Transparency helps promote ethical and moral behavior.[7] Transparency of systems can clarify responsibility and make outcomes understandable. Users can better understand the underlying processes the system used to arrive at an outcome and use that knowledge to make correct decisions. Without transparency, it is much easier to maliciously use and control systems. Moreover, insufficient transparency may jeopardize human trust in autonomous systems.[8]

Cybersecurity

Cyberattacks are geographically unconstrained compared to physical attacks. The original designers of cyberweapons are hard to identify, while vulnerable systems are countless, including healthcare systems, transport networks, traffic light systems, and food distribution systems. Cybersecurity affects system reliability, which, in turn, affects user trust in these systems. Enhanced cybersecurity and better protection of data will reduce ethical and moral problems and complications. This is in line with one of the ethical principles suggested by the US Department of Health, Education, and Welfare's "Belmont Report": do no harm to participants.[9]

Conclusion

Keeping ethics and moral values high in Industry 4.0 has become more critical than ever. Although there is no one-size-fits-all approach to solving ethical issues, basic frameworks to guide behavior must be explored and formulated. In this article, we have discussed potential ethical issues from three perspectives: (1) ethical forces in Industry 4.0; (2) ethical issues related to big data; and (3) ethical issues related to systems, products, and services. Only when we establish and follow ethical and moral principles for various aspects of Industry 4.0 can we achieve a society that will truly benefit from Industry 4.0.

The educational system must train students, especially those studying computing and software engineering, in ethical principles. The educational system must also be reengineered to educate students and workers to

become more qualified in Industry 4.0, where the release of platforms/systems is much faster than we have seen to date and the skill sets required are constantly changing. Graduates are expected to be work-ready and know the latest technology trends and tools. The ability to think critically and the embracing of lifelong learning are extremely important,[10] as those who have these characteristics can adapt to the challenges of Industry 4.0 and be less subject to replacement by machines and intelligent agents.

Organizations must set up governance systems to ensure protection of operations and business ethics. Data privacy policies should integrate into business operations. The European Union has responded to the data misuse threat through the issuance of the General Data Protection Regulation; failure to comply with the regulation is subject to a fine of up to either 4% of an organization's global turnover or €20 million. Similar regulations should be implemented in other regions to protect data privacy and security.

Understanding and addressing ethical and moral issues related to Industry 4.0 is still in its infancy stage.[11] Addressing ethical and moral issues is not a simple discussion of "right or wrong," "good or bad," or "virtue to vice." It is not even a problem solvable by a small group of people. However, formulating and developing ethical and moral principles related to Industry 4.0 are critical. Industry 4.0 is transforming jobs, societies, and humanity. The future development of Industry 4.0 needs to be guided by sound ethical and moral principles.

References

[1]Danova, Tony. "Morgan Stanley: 75 Billion Devices Will Be Connected to the Internet of Things by 2020." *Business Insider*, 2 October 2013.

[2]Centre for the New Economy and Society. "The Future of Jobs Report 2018." World Economic Forum, 17 September 2018.

[3]Wang, Weiyu, and Keng Siau. "Artificial Intelligence, Machine Learning, Automation, Robotics, Future of Work, and Future of Humanity: A Review and Research Agenda." *Journal of Database Management*, Vol. 30, No. 1, 61-79, January 2019.

[4]Vitak, Jessica, Katie Shilton, and Zahra Ashktorab. "Beyond the Belmont Principles: Ethical Challenges, Practices, and Beliefs in the Online Data Research Community." *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. ACM, pp. 941-953, 2016.

[5]"The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research." US Department of Health, Education, and Welfare. Publication No. (OS) 78-0014, 18 April 1979

[5]Wallach, Hanna. "Big Data, Machine Learning, and the Social Sciences: Fairness, Accountability, and Transparency." Medium, 19 December 2014.

[6]Mason, Richard O. "Four Ethical Issues of the Information Age." *MIS Quarterly*, March 1986.

[7]Wallach (see 5).

[8]Siau, Keng, and Weiyu Wang. "Building Trust in Artificial Intelligence, Machine Learning, and Robotics." *Cutter Business Technology Journal*, Vol. 31, No. 2, 47-53, 2018.

[9]US Department of Health, Education, and Welfare (see 5).

[10]Siau, Keng. "Education in the Age of Artificial Intelligence: How Will Technology Shape Learning?" *The Global Analyst*, Vol. 7, No. 3, 2018.

[11]Wang, Weiyu, and Keng Siau. "Ethical and Moral Issues with AI." Proceedings from the *24th Americas Conference on Information Systems*, New Orleans, Louisiana, USA, 16-18 August 2018.

Weiyu Wang holds a master of science degree in information science and technology and an MBA from the Missouri University of Science and Technology. Her research focuses on the impact of artificial intelligence (AI) on economy, society, and mental well-being. She is also interested in the governance, ethical, and trust issues related to AI. She can be reached at wwpmc@mst.edu.

Keng Siau is Chair of the Department of Business and Information Technology at the Missouri University of Science and Technology. Previously, he was the Edwin J. Faulkner Chair Professor and Full Professor of Management at the University of Nebraska-Lincoln (UNL), where he was Director of the UNL-IBM Global Innovation Hub. Dr. Siau also served as VP of Education for the Association for Information Systems. He is Editor-in-Chief of Journal of Database Management, *has written more than 300 academic publications, and is consistently ranked as one of the top IS researchers in the world based on h-index and productivity rate. Dr. Siau's research has been funded by the US National Science Foundation, IBM, and other IT organizations. He has received numerous teaching, research, service, and leadership awards, including the International Federation for Information Processing Outstanding Service Award, the IBM Faculty Award, and the IBM Faculty Innovation Award. Dr. Siau received his PhD in business administration from the University of British Columbia. He can be reached at siauk@mst.edu.*