Is Technical Innovation Serving Socially Inclusive Business?

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"To meet the ethical challenges posed by the imposition of new paradigms and forms of power derived from technology"[1] we have to better understand:

1. Driving forces of technical innovations
2. Business opportunities of new technologies
3. Ethical norms and values to direct technical innovations
   in a way that they are serving socially (inclusive business)

Technology has become a game changer for mankind at least since the industrial revolution. In 1891 Pope Leo XIII was addressing these changes (industry 1.0) in *Rerum Novarum*, mother of all encyclicals of Catholic Social Teaching (CST).[2] Since then, CST has developed parallels to the changes of the industry (1900: Industry 2.0, Assemblyline and Piecework; 1950: Industry 3.0, Computer and Automation). Now, we are facing the *New Things* of Industry 4.0. What are the technological features, systems and paradigms? How can and should we respond from a christian perspective of social ethics?

1. Driving forces of technical innovations

Industry 4.0[3] is characterized by the interoperability of machines and humans and a combination of technology as digitalization, robotics, nanotechnology, biotech and neuroscience.

[1] Pope Francis, Address to the CAPP Foundation, Vatican, 20.05.2017.
[2] Rusche, T. (2017). Digital Transformation of our (Economic) Society, p. 1.
[3] The term Industry 4.0 was coined at Hanover Fair 2011; see Industry 4.0: Mit dem Internet der Dinge auf dem Weg zur 4. industriellen Revolution, VdI-Nachrichten.com, 01.04.2011).

1.1 Increasing computing power

The dynamics of this ongoing revolution owes its technological breakthrough to the coded transmission of information with an exponential increase of computing power.[4] Our smartphone of today wields a greater computational power than all the NASA computers combined that made the first landing on the moon in 1969 possible. In the 21st century this accelerating performance could lead to a progress 1.000 times bigger than in the 20th century.[5]

A relevant criteria for a better understanding of the increasing computing power is the sum of calculations per second (cps) a human brain can manage: ca. 10^{16} (10 quadrillion) cps. In 2015, the Chinese Supercomputer *Tianhe-2* ($390 million production cost) reached a capacity of 34 quadrillions cps, the forthcoming *Tianhe-3* will beat its predecessor with a ten times higher computational power.[6] By 2025, an affordable $1.000 computer will reach the human cps capacity, empowering the digital transformation.

1.2 Digital innovations reinforce each other

The fifth generation of wireless mobile network systems (**5G)** expected in the early 2020's will have faster speed, improved coverage and enhanced signaling efficiency. Therefore, leading to a higher reliability of communication. **Cloud computing** allows the mobile user to access shared computer processing resources like data, tools and services everywhere and at any time. Whenever we are using the internet and clicking on Google search results, we are filling the global information-storage. Digital interaction leads to *big data*, in most cases a cost free byproduct. Big data is a huge and steadily growing data storage *(volume)*, often immediately available *(velocity)* and of a broad (*variety* - audio, figures, pictures, text, video). It cannot only be used to analyze users past behavior, but also for predictive analytics e.g. to identify potential criminal activity (predictive policing).[7]

Blockchains are secure storage for big data with access limited to defined parties within a peer network. Blocks within the chain are recording data in a verifiable way. Hence, without knowing each other peers can trust the data e.g. records of events. Blocks are rigid structures

[4] See Meyer, M. (2017). Die Digitalisierung als sozialethische Herausforderung, p. 6.
[5] See Kurzweil, R. (2001). The Law of Accelerating Returns, Essay, 07.03.2001.
[6] See Freitag, J. (2017). Eine Trillion Rechnungen in der Sekunde, FAZ-net, 20.02.2017.
[7] See Rienks, R. (2015). Predictive Policing: Taking a Chance for a Safer Future, 14.07.2015.

containing real transaction data. They are connected in a chain by a hash. Each block has a timestamp and a header including metadata. Data within a block can only be altered by changing the whole chain and with consensus of all network participants. Blockchains are value-exchange protocols and therefore secure data storage, most commonly used for contracts, medical records and transaction processing. The blockchain technology allows cryptocurrencies like bitcoin to function without a trusted central server as the lender of last resort. In the future, security, privacy and efficiency of blockchains will be leveraged, as more or less all other digital technology and applications by the rise of Artificial Intelligence.[8]

1.3 Rise of Artificial Intelligence (AI)

Increasing computing power and brain research has become important 'providers' for the development of AI.[9] AI research analyzes cognitive human functions such as learning and problem solving, in order to develop computerized intelligent agents. In 2016, an AIagent (AlphaGo) won 4:1 against the world's best player, Lee Sedol, in the most complicated board game. To prepare for this victory, AlphaGo had to study several thousand Gogames to increasingly better understand rules and strategies, all in a supervised learning process. The AIagent is fed with data filtered by human experts. This supervision is not only costly, but it is also limiting the computers abilities to the knowledge of those human experts.

In Oct. 2017, *Nature* published an article on AlphaGo Zero[10]. AlphaGo Zero started learning the game without a given dataset, just knowing the rules and being programmed with a reward function. Due to such unsupervised learning it was playing in a distinctly non-human way, winning 100:0 against AlphaGo within three days. By using algorithms the AIagent has accumulated more Go-knowledge in a few days than human GoPlayers over thousands of years.[11]

By only using algorithms an AIagent is able to solve a specific problem better than a human. Although this is an important step for the rise of AI, the knowledge is still restricted on a

[8] See Corea, F.: The convergence of AI and Blockchain: what's the deal, 1 Dec, 2017.

[9] The term 'Artificial Intelligence' was coined in 1955 in the preperational paper for the Dartmouth Conference (1956) by the former Kyoto price winner (1988) John McCarthy (1927-2011). At the Dartmouth Summer Research Project on Artificial Intelligence John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon have laid the academic foundation of AI.

[10] Silver, D./Schnittwieser, J./Simonyan, K.: Mastering the game of Go without human knowledge, Nature, 550 (7676), pp. 354-359.

[11] See The Economist, Artificial Intelligence. Going places, 21 Oct, 2017, pp. 75-76.

specific area (ANI: Artificial Narrow Intelligence), such as playing Go or chess, driving a car or tracking protein in cells. Now, companies like DeepMind (developer of AlphaGo) DeepLearning or the Chinese rivals Alibaba and Baidu are investing heavily to develop a master algorithm, that creates Artificial General Intelligence (AGI). Such a general AIagent would be able to quickly solve any complex problem across the fields of science and applications by learning from its own experience. Within the AI research community there is little doubt that such a strong AI will be developed. Even the artificial superintelligence (ASI) seems to be on the horizon. Such a super intelligent agent would have "an intellect that is much smarter than the best human brains in practically every field including scientific creativity, general wisdom and social skills".[12]

The mere possibility of ASI leads to the hypothesis of (technological) singularity. Singularity is on stage, when the intelligence explosion leads to self-improvement cycles, which are surpassing all human intelligence in a runaway reaction.[13]

Enabling such a process of recursive self-improvement is the far reaching goal of AI research. It leads not only to huge business opportunities, but also to fundamental ethical challenges for mankind.

2. Business opportunities of new technologies

Rapid technological innovation leads to a disruption in the way that institutions like firms are usually processing. In the past, most of management planning was linear. Forecasts were based on experience. Now, digitalization leads to new business models with exponential growth. Well established companies are under attack and old fashioned management teams are quite often not prepared for these dramatic changes.

2.1 Data management

Every business process of a company can be rendered into digitalized programs. This requires large data quantities and the ability to analyze them profoundly. For digitally transformed enterprises, data turns into claims for prospecting gold. By means of gathering data,

[12] Bostrom, N. (2006). How long before superintelligence, pp. 11-30.

[13] John von Neumann (1903-1957) has already "centered on the accelerating process of technology and changes in the mode of human live, which gives the appearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue" (Stanislaw Ulam, Tribute to John von Neumann, p. 5).

management can make decisions precisely to the point. In a production line costs are minimized, in retailing stock can be reduced and services customized for gaining a higher turnover.

As large computing capacities become available at cheaper rates, digitalized start-ups see a mostly low barrier of entry, especially the capital demand for hardware as warehouses and all kind of 'brick and mortar' is little. It is well known today that the world's biggest retailer (Alibaba) owns no inventory, the biggest provider of overnight stays (Airbnb) no hotel estates and the biggest taxi company (Uber) has no cars in their assets.

2.2 Platforms and networkers

The winners of digital disruption build platforms and link up demand and supply without themselves providing or possessing the goods offered and demanded. Platforms are changing the fundamental rules of business "from controlling to orchestrating resources; from optimizing internal processes to facilitating external interactions".[14]

Platforms make use of the Sharing Economy, the systematic providing and reciprocal borrowing and lending of goods and resources. The automobile as a status symbol increasingly loses its meaning. Owning one, two or even three cars, which, in case of doubt, are parked at the wrong place, is less desirable than falling back on a 'car to go' anytime and anywhere.

Platforms help themselves with cloud-computing and reach their audience via software nets, which they do not have to set up themselves at considerable costs, but which they use via interface without financing hardware and IT-development. For cloud clients, this is efficient, as only the service actually used is being charged. When software nets link up with electronic production structures, industry 4.0 can jump on this bandwagon, in which the individual production of products is cost-efficiently possible, leading to strategic advantages of specialization.

In the netted designing of thoroughly digitalized services of product and performance, start-ups in most cases act in a more agile fashion than enterprises established in pre-digitalization times. The latter, organized by a rigid linear hierarchy, leaves little room for creatively organizing projects where digital concepts are bred and realized. Such incubators are the

[14] Alstyne, M. W. v. (2016). How Platform Businesses are Transforming Strategy, p. 1.

nuclei of a new digital wave of founders, which, within the framework of a creative process of destruction, push analogous and encrusted enterprises out of the market.

Digital network effects are creating a dominance of GAFA (Google, Apple, Facebook, Amazon) in the west and BAT (Baidu, Alibaba, Tencent) in China. The value of the GAFA/BAF products and services is increasing by each additional user, producing a higher factorial (!) relation with exponential growth.

2.3 Digital monopoly

Network effects lead to a worldwide digital monopoly, which is nearly unregulated, due to a lack of international antitrust, fiscal and labour laws. Digital monopolists like GAFA are expanding relentlessly, not despite, but because of their huge size. The more data they collect and analyze, the bigger their use for a growing network community. These datakrakens are maximizing their monopolist's profit: The winner takes it all. The expanding GAFA Economy is in line with the shareholder model based on the utilitarian business approach, which claims that the action which maximizes utility (e.g. profits) is the best.

Within this utilitarian business model it is difficult to develop a stakeholder approach. The interests of others are only taken into account if this is useful to maximize the profit at least in the long run. Questions of justice are ignored, the pursuit of common good is not intended.

3. CST in the digital age

Without a proper understanding of reality, ethic is a glass bead game. Therefore, we have to analyse the *rerum novarum* of our 21st century, in order to recognize ethical challenges. Within the limits of this paper, I shall concentrate on the technical innovation of AI. How can artificial intelligence serve socially inclusive business?

3.1 Ethical challenge of AI

The GAFA/BAT industry is investing billions to increase their AI capabilities.[15] "An exponential increase in the availability of digital data, the force of computing power and the

[15] Google alone spent 500 million US-$ on Deep mind/Deep learning to develop AlphaGo.

brilliance of algorithms has fuelled excitement about this formerly obscure corner of computer science"[16] Companies are fighting for talents to develop AI knowledge, which leads to exponential extension of working force quality and a reduction in the quantity of employees.[17] In general, technical innovations, especially the use of AI for machine learning, will have grave employment implications. Overall, 50% of job activities worldwide can potentially be automated by AI-based computer technology. On the other hand, these innovations will create new jobs globally. These job shifts will affect more or less everybody. Either losing one's job and hopefully finding a new one or facing substantial changes in job descriptions and contents.

As test scores show, information technology has had no or little positive effects on school education up to now. In the future, AI will be helpful to educate people regarding new challenges in business and life. AI based educational technology (edtech) "is letting machines learn about the pupils using them by studying the data produced in the process (…). Pupils receive feedback that 'even the best teacher could not provide to all of class' ".[18] An AI based science of education can personalize the learning process and will help to create socially inclusive formation systems worldwide.

On the road from ANI to AGI, the GATA/BAF economy is heavily investing in brain research, aiming for brain-computer interfaces (BCIs). "Brain-computer interfaces may change what it means to be human".[19] Take the example of Bill Kochevar, a paralyzed man, who moves his arm and hand to feed himself by computerized mind control. A microchip is implanted in his brain stimulating the neural activities in the motor cortex commanding the electrodes in his arms. Nanotechnology allows the development of smaller and smarter brain implants, helping the blind, controlling Parkinson's disease and monitoring signs of depression. The more powerful these BCIs will become, the more ethical challenges will arise.

On the forthcoming road from AGI to ASI brain research has a leverager. Plagiarizing the brain is one of the key issues to create superhuman AIagents. "The real risk with artificial

[16] The Economist, Artificial Intelligence. Battle of the brains, 9 Dec, 2017, p. 61.
[17] Eg. Apple a company with the highest market capitalization has only 120.000 employees compared with WalMart (2.000.000 employees).
[18] The Economist, Machine Learning, 22 Jul, 2017, pp. 16-17.
[19] The Economist, The next frontier, 6 Jan, 2018, p. 7.

general intelligence isn't malice but competence. A super intelligent AI will be extremely good and accomplishing its goals, and if those goals aren't aligned with ours, we're in trouble".[20]

Max Weber (1864-1920) has shown that choices of goals are not only interdependent with given means, but also influenced by the value-set of a decision maker. Without a clear and precise understanding of moral values, AI can be misused for any goal as the most powerful tool mankind has ever created. To avoid this, there is a need of social ethical reasoning.[21]

3.2 Moral substance of social ethical principles

The goal of CST is to assure *human dignity* and to increase the *common good* worldwide. Social ethical principles provide a meaningful framework for "social processes, structures and institutions"[22] and the dramatically changing conditions of our modern industrialized society. How can this order of ethics be grounded and applied to situations and challenges of our digital transformed world?

3.2.1 Personality and sociality

Man is more than data profile that can be put into algorithms. As an image of God s/he is endowed with a self-evident unalienable dignity. The foundation of CST is the sanctity of human life. Never must Man be turned means for other purposes. This unconditional respect of Man is valid either in cyberspace or in analogous face-to-face situations.

Man is in need of fellow-man to become a personality. The human person finds its "fulfillment only when touching others. It is open, can be spoken to and is set for dialogue".[23] Social interactions are the condition for his/her moral and personal development. Digitalization is no value in itself, but rather a technical mean to help socially unfold personality through communicative networking and social inclusion. In the light of CST any technical innovation makes sense only when serving (worldwide) realization of humaneness.

[20] Tegmark, M. (2017), Life 3.0.

[21] Now ethical debates „are shifting from philosophy faculties to departments of engineering and computer science. And whereas philosophers are patient people, engineers are impatient, and hedge fund investors are more restless still. When Tesla engineers come to design a self-driving car, they cannot wait while philosophers argue about its ethics" (Harari, Y. N., Life 3.0, p. 5).

[22] Küppers, A. (2017). Die Ordnungsethik der katholischen Soziallehre, p. 6.

[23] Höffner, J. (2017). Christliche Gesellschaftslehre, S. 31.

3.2.2 Solidarity and subsidiarity

The christian message of love fulfills itself in perfect human mutuality. Discovering oneself in the mirror of fellow-man, means both to stand by his side and understand his wishes and anxieties. In the digital world, too, there is need for a reliable social intercourse, which offers everybody freedom and secures necessary support. In a solidary community, the stronger helps the weaker. Complimentary to solidarity, the principle of subsidiarity allows the individual to regulate and achieve what s/he can do him/herself without being patronized by other individuals, organizations or state authorities. This subsidiary ranking and differentiation of individual micro level, entrepreneurial meso level and state macro level, simultaneously make clear a far reaching co-responsibility of the individual and of business for society at large. How can an agent contribute to the common good e.g. using technical innovations like AI to serve socially inclusive business?

Lacking or available financial means and social relationships, poverty or wealth, as well as (lacking) education decide on the access to the digital world. This digital divide of our society deserves active solidarity and subsidiarity: somebody born into this digital world, enjoying respective resources helps the pre-digitally socialized human beings who, on their part, oblige themselves to a continuous digital education. Digital natives prepare pre-digital fellow-men for coming technological changes. Everybody seeks to learn, within his/her means, responsibly handling new technologies. This corresponds to the social ethical motto that the human being gains perfection by his activities (omne agens agendo perficitur). Enterprises open internal digital spaces of communication (Intranet) and make an electronic linking with their co-workers and their stakeholders (e.g. suppliers and clients) possible. To unfold digital potential of development, each co-worker is entrusted with a space of decision-making as large as possible and is secured the necessary technological support. Enterprises protect co-workers from electronic mobbing and technological overexertion at the workplace. Responsible enterprises leave their outdated computers to aid organizations such as Digital Helpers,[24] which refurbish the devices and distribute them to socially-digitally under-privileged people, e.g. destitute immigrants, for free.

[24] www.digitalhelpers.org.

3.2.3 Justice and mercy

On the grounds of unevenly distributed chances and individual skills, one must demand from the principle of justice that "human beings despite all other differences must be recognized as basically equal and therefore, despite all possible inequality, at least given the same chances to unfold their potentials".[25] CST turns against an utilitarian approach of utility maximization fomented by technical innovations at the expense of ostracized minorities, due to their lack of digital qualifications.

Justice is the least measure of love we humans owe each other, mercy its superior measure. At first "love and mercy have their place in close human relationships. But they are also a basic condition for people living together and among peoples".[26] Especially in a digital transformed society, there is a need for mercy and becomes concrete in an understanding, helpful dealing with pre-digital people, who feel excluded from technological progress and with digitally demented people, who have partially lost their sense of orientation in the analogous world.

The progress of digital innovations is leading to a turmoil for those who will lose their jobs or companies and social status. The existing social structure will be reshaped with more or less dramatical consequences for each human being. Facing social shifts, mercy can become an "innovative and motivating source of social justice"[27] enabling each human being to live a rewarding life.

3.3 AI in the light of CST

How can technical innovation like AI serve socially inclusive business? How can "responsible imparting"[28] of social-ethical principles succeed under changing conditions of a digital transformed society? How can personality and sociality, solidarity and subsidiarity, justice and mercy be brought into the play of the protagonists on the action level of individuals and teams (Micro), enterprise and systems (Meso), state and world (Macro)? The 9 fields matrix in figure 1 is using these analytical dimensions for a better understanding of those 23 AI

[25] Furger, F. (1992). Moral oder Kapital, p. 137.
[26] Kasper, W. (2013). Barmherzigkeit, p. 194.
[27] Kasper, W. (2013). Barmherzigkeit, p. 194.
[28] Weber, W. (2017). Christliche Ethik zwischen Anpassung und Widerstand, p. 12.

principles, formulated in Asilomar in 2017, signed by 1273 AI researchers and 2541 other endorsers.[29]

Already Wilhelm Weber (1925-1983) postulated a CST "capable of dialogue".[30] In order to analyse, judge and act, it is necessary to watch and to listen. In an intellectual dialogue of people concerned and involved with the development of AI these new things can be evaluated. This requires not only an education in social ethics and the digital specialist's knowledge but also heeding the imperative for discourse: >>Argue meaningful, be credible and seek consensus<<, in this case about the actual situation and the future dynamics of AI research and its potential effects on humanity.
Without a dialogue of all people involved and affected, these technical innovations will not serve socially inclusive business. Improving the quality of dialogue by a free exchange of all relevant arguments opens the door for the permanence of genuine human life on earth (Hans Jonas).

Figure 1: Social ethical reflection on the action fields of AI

[29] https://futureoflife.org, 29.1.2018.
[30] Weber, W. (2017): Christliche Ethik zwischen Anpassung und Widerstand, p. 12.

Level of Activities / Social Ethical Principles	MICRO LEVEL of Individuals and Teams	MESO LEVEL of Enterprises and Systems	MACRO LEVEL of State and World
Personality and Sociality	§4 Culture of cooperation and trust between AI researcher §9 Responsibility of AI designers to shape moral implications of AI use and misuse §13 AI use of personal data must not curtail people's liberty and privacy	§6 AI systems should be safe and secure §7 Failure transparency of AI-Agents §10 Goals and behaviours of AI-systems should aligne with human values	§8 Humans must audit judical AI decision-making §19 Without consensus avoid strong assumptions regarding upper limits on future AI capabilities
Solidarity and Subsidiarity	§ 5 Race Avoidance between AI teams §16 Humans should choose how and whether to delegate decisions to AI systems, to accomplish human-chosen objectives	§1 No undirected, but beneficial intelligence §2.2 AI must grow prosperity while maintaining people's resources and purpose §14 AI should benefit and empower as many people as possible	§3 Constructive exchange between AI researchers and politicians §15 The economic prosperity created by AI should be shared broadly to benefit all of humanity §17 AI should improve the civic health of society §20 AI could represent a profound change in history of live and earth
Justice and Mercy	§11 Ideals of human dignity, rights, freedom and cultural diversity should design and operate AI §12 People should have the right to access, manage and control the data they generate for the use of AI	§2 AI research must ensure law, ethics and social study §2.1 AI systems must do what we want without malfunctioning or getting hacked §22 Recursive self-improvement AI-systems must be subject to strict safety and control measures	§2.3 Fair and efficient legal system managing AI's risks §2.4 Legal and ethical status of AI values §18 Avoid an AI arms race with lethal autonomus weapons §21 Especially catastrophic risks posed by AI must be subject to planning and mitigation efforts §23 ASI should only be developped for the benefit of all humanity (common good)

Figure 1: Social-ethical reflection on the action fields of AI

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