

**THE FUTURE OF THE WESTERN CAPE AGRICULTURAL  
SECTOR IN THE CONTEXT OF THE 4<sup>TH</sup> INDUSTRIAL  
REVOLUTION**

**Review: The Fourth Industrial Revolution (4IR)**

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# 1. Introduction

## Setting the scene

Industrial revolutions occur when new technologies and world views introduce significant shifts in economic systems and social structures.<sup>1</sup> Our current reality is that technological advancement is increasingly transforming the way we work, live, communicate, travel and socialise, which, at the rate it is going, could fundamentally alter life, as we know it. So profound could it be that renowned futurist Ray Kurzweil predicts a future period during which the pace of technological change will be so rapid, its impact so deep, that human life will be irreversibly transformed.<sup>2</sup> In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before, and humankind now finds itself at the genesis of a revolution considers to be the Fourth Industrial Revolution (4IR).<sup>3</sup> The term 'Fourth Industrial Revolution', also known as Industry 4.0, has its roots in Germany's federal government 2011 high-tech strategy, and commentators believe that Industry 4.0 will leverage the internet, digital technologies and quantum sciences to drive further into autonomous, intelligent cyber-physical systems.<sup>4</sup>

More than sixty years ago economists Shepard Clough and Charles determined that the prerequisites for an Industrial Revolution rests on six fundamentals, namely, capital, capitalism, markets, labour, natural resources, and machines.<sup>5</sup> As far as the First Industrial Revolution is concerned, if the sudden, qualitative and fundamental transformation, which happened in or about the 1780s, was not a revolution then the word has no common sense meaning.<sup>6</sup> England and France serve as case in point, as conditions in these two countries met the prerequisites for industrialisation more adequately; hence their prominence in the unfolding of the first industrial revolution. In terms of industrial revolutions spanning humanity's existence, Table 1 below provides a useful introductory snapshot.

Table 1: Industrial Revolutions over time<sup>7</sup>

	Agricultural Revolution	1 <sup>st</sup> Industrial Revolution	2 <sup>nd</sup> Industrial Revolution	3 <sup>rd</sup> Industrial Revolution
Time	5000BC – 18 <sup>th</sup> Century	19 <sup>th</sup> Century	20 <sup>th</sup> Century	21 <sup>st</sup> Century
Energy Construct	Horsepower & water	Steam	Oil & Electricity	Renewable
Communications Technology	Writing	Cheap printing (Convergence of linotype and press)	Telephony & Media	Digital Networking
Form of social organisation and settlement	City States Hydraulic Civilisation	Factory based cities	Suburban conurbation	Interconnected 'village' ecologies

## What to expect in this review

This discussion to follow, sets out to provide an overview of 4IR, starting off with historically contextualising the time-lapse and accompanying unfolding of events between what was and what is, i.e., considering the first-, second- and third industrial revolutions, as well as a brief synopsis of innovation and macroeconomic cycles in relation thereto. This is followed by a detailed expose of 4IR.

## 2. Historical context

### The evolution of industrial revolutions

Four stages can be distinguished in the ongoing process called the Industrial Revolution, with the first occurring toward the end of the 18th century, introducing mechanical production driven by water and steam. The 2nd industrial revolution at the beginning of the 20th century saw the introduction of the conveyor belt and mass production, and the 3rd the digital automation of production by means of electronics.<sup>8</sup> Similarly, Schwab (2016:20) views the sequence of industrial revolutions as beginning in the second half of the 18th century, with the 1st ranging from 1760 to 1840, triggered by the invention of the steam engine and the construction of railroads and, ushering in mechanical production. Late in the 19th century, leading into the early 20th century introduced the 2nd, ushered in by the arrival of electricity and the assembly line which made mass production possible. Often referred to as the computer or digital revolution, the 3rd industrial revolution began in the 1960s, with the development of semiconductors, mainframe computing (1960s), personal computing (1970s and 80s) and the Internet (1990s) as the main drivers.

Hwang (2016:10) elaborates, stating that the 1st industrial evolution occurred in the late 18th century, emphasising steam engines, which enabled the textile industry and other mechanised systems to flourish. The final third of the 19th and beginning of the 20th centuries saw the 2nd second industrial revolution unfolding with the introduction electricity induced mass production, creating the steel industry, telegraph and railroad systems. With the of transistor's invention in 1947, the dawn of the digital age and information technology was introduced, which in the 1970s spawned the 3rd industrial revolution of computers and electronics. This era set the scene for vigorous economic development and the advancement of manufacturing through the utilisation of information and automation technology, marking the advent and continued progress of the vibrant and fast-paced digital era. In sum: Roughly 250 years spans the evolution from the 1st to the 4th industrial revolutions, as illustrated in figure 1 below.

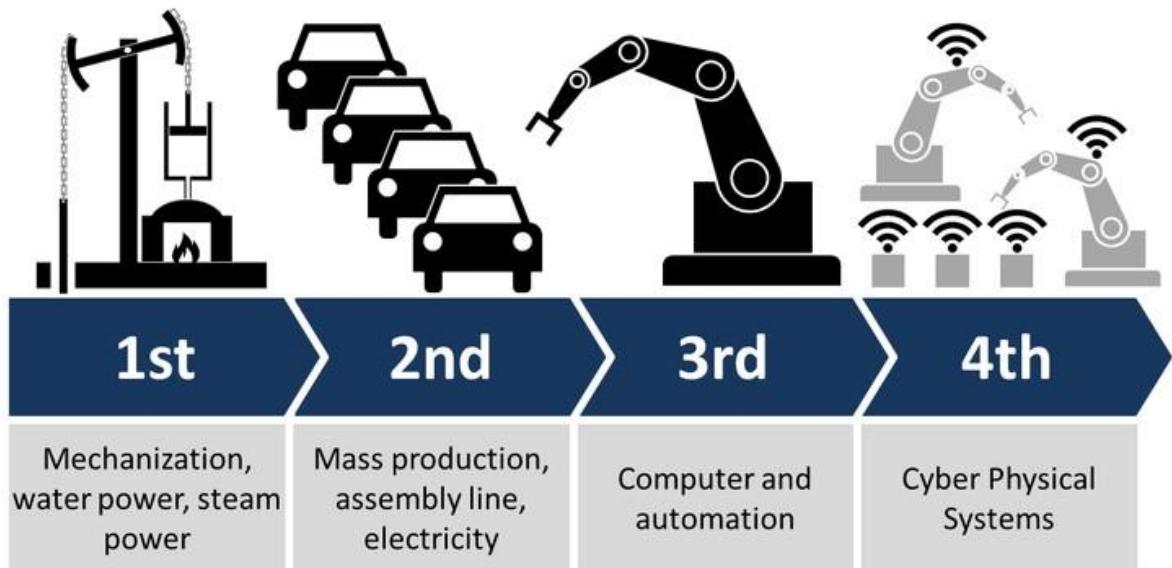


Figure 1: Industrial Revolutions over time<sup>9</sup>

Another important consideration when observing the evolution of industrial revolutions, is the degree of complexity. Figure 2 below illustrates the evolution from the introduction of mechanical production facilities aided by steam and water, to that of cyber-physical production systems which converge the physical and virtual worlds, with the associated increase in degree of complexity.

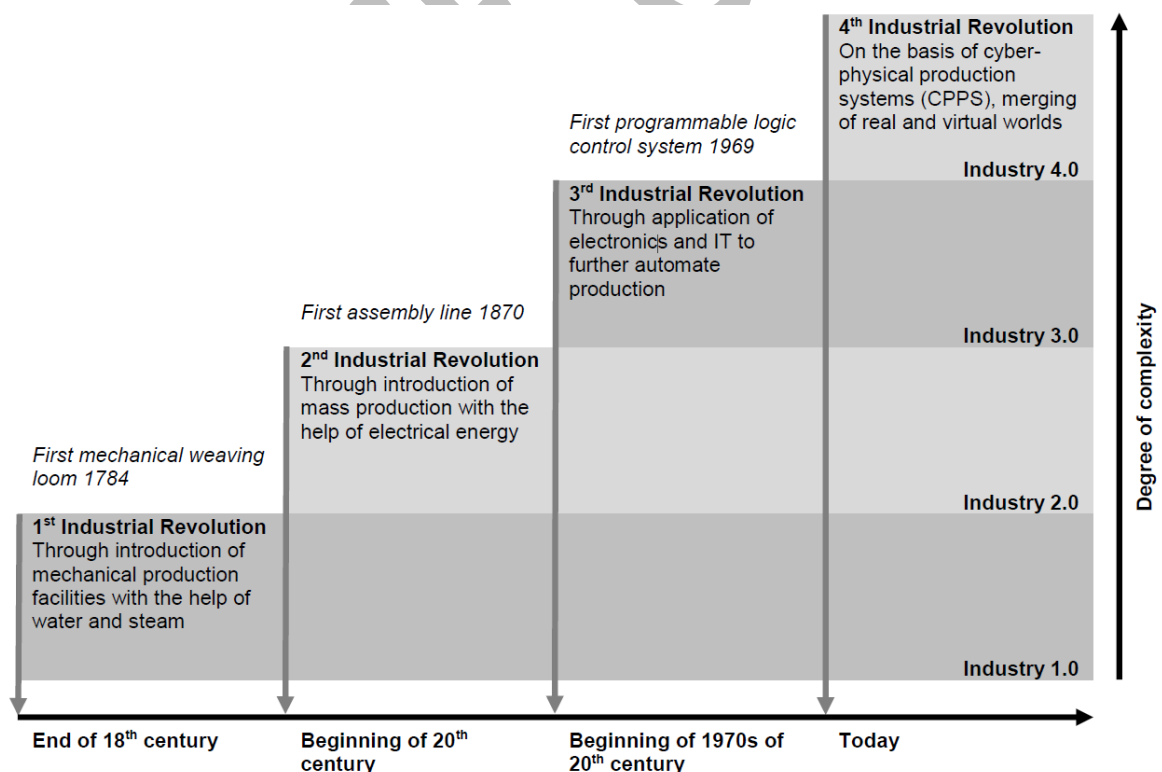


Figure 2: The evolution of industrial revolutions and associated degrees of complexity<sup>10</sup>

A noteworthy observation, contrary to popular belief that Klaus Schwab, founder and chairman of the World Economic Forum introduced the term ‘Fourth Industrial Revolution’, is that the term can be traced back to 1983 when W.W. Rostow, Professor of Political Economy at the University of Texas at Austin, used it in an essay on industrial revolutions in relation to Russian economist Nikolai Kondratiev’s “long waves” theory associated with capitalist economies.<sup>11</sup> Hence, a brief discussion on innovation and macroeconomic cycles as it relates to industrial revolutions is deemed necessary.

## Innovation and macroeconomic cycles

Russian economist Nikolai Kondratiev (1892-1938) identified major long-wave economic cycles associated with capitalist economies. The innovation theory attributed these waves to the clustering of basic innovations that introduce technological revolutions, thereby creating new industries or business sectors. Building on the Kondratiev waves, economist, Joseph Schumpeter (1883-1950), in the 1930s, developed a theory which predicted the existence of very long-run macroeconomic cycles, originally estimated to last 50-55 years. Schumpeter emphasised the link between entrepreneurial discovery and economic progress in the form of five waves of industrial innovation (See Figure 3).<sup>12</sup> Noticeably these waves align closely with the periods considered industrial revolutions.

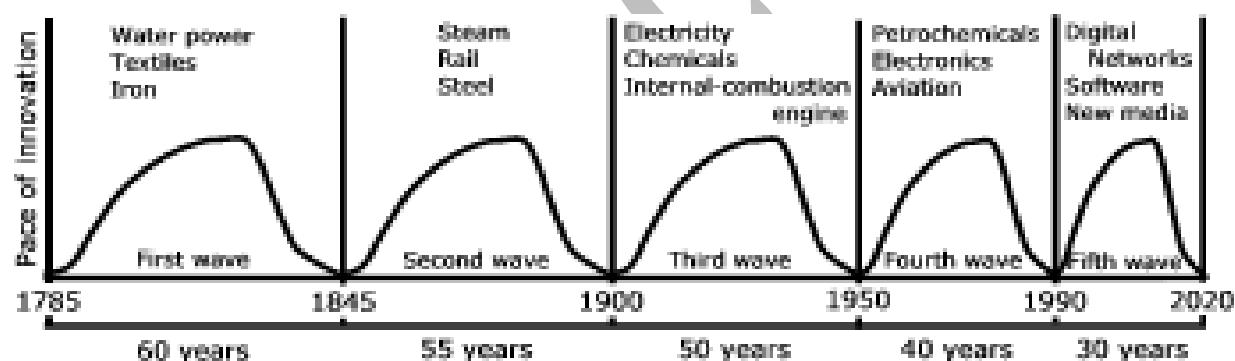


Figure 3: The Schumpeter innovation waves

It was in relation to what Rostow called the “Fifth Kondratiev Upswing” which he referred to as the “Fourth Industrial Revolution.” Believing that it was in its early stage, Rostow defined it “as embracing innovations in microelectronics, communications, the offshoots of genetics, the laser, robots, and new synthetic materials. Before it runs its course, it may yield breakthroughs in photovoltaic cells, hydrogen, and more economical ways of producing synthetic oil.” Interestingly, he expressed concern about robots as the component in the Fourth Industrial Revolution that lies at the heart of technology and future employment prospects.<sup>11</sup>

One could argue, in relation to commentaries in the preceding sections, that Rostow’s views are out of sync with more than three decades. On the other hand, he might have had a valid argument if only to be considered as the embryo-phase of what is considered to be a time of unprecedented speed of change, leading to extensive and fundamental

transformations.<sup>13</sup> Of noticeable importance in figure 3 is the decreasing frequency of the waves, indicative that innovation is accelerating. Considering the current rate of innovation, there appears to be every reason to believe that Schumpeter's theory is accurate (Silva & Di Serio, 2016:130), and that we are moving out of the fifth wave, rapidly approaching the next (sixth) innovation wave.

Against this backdrop, the scene is set to further explore the notion of the fourth industrial revolution.

### 3. The Fourth Industrial Revolution (4IR)

#### What makes 4IR different to the previous industrial revolutions?

Klaus Schwab, Founder and Chairman of the World Economic Forum believes humanity to be at the beginning of a fourth industrial revolution, spawned at the turn of this century and building on the digital revolution. What makes 4IR fundamentally different from its predecessors is that its scope is much broader than mere smart and connected machines and systems. The simultaneous occurrence of waves of further breakthroughs in areas ranging from gene sequencing to nanotechnology, from renewables to quantum computing, the fusion of these technologies and their interaction across the physical, digital and biological domains is what sets 4IR apart.<sup>3</sup> The world is pivoting away from the third industrial revolution to a fusion of the physical and the virtual world, interoperability, advanced artificial intelligence and autonomy that are becoming integral parts of a new industrial era.<sup>4</sup>

The British House of Commons describes 4IR as "a vaguely defined term used to refer to a variety of technological changes and innovations that have occurred since the beginning of the 21st century, with potentially dramatic effects on economy and society. It is characterised by increased automation of working practices, effecting both low and middle skill jobs, greater connectivity, machine learning and developments in new and emerging technologies, occurring at a considerably faster pace than in preceding industrial revolutions."<sup>14</sup> Three reasons are emphasised to support the conviction that a fourth and distinct revolution is underway:

1. **Velocity:** Different from the previous industrial revolutions, 4IR is evolving exponentially rather than linearly, ascribed to the multi-layered, deeply interconnected world and newer and ever more capable technology produced by new technology.
2. **Breadth and depth:** Building on the digital revolution it combines multiple technologies that are leading to unparalleled paradigm shifts in the economy, business, society, and individually.

3. **Systems Impact:** It comprises the transformation of entire systems, across (and within) countries, companies, industries and society.<sup>1</sup>

In addition, the uniqueness of 4IR inherently lies in three features: (1) it involves three aspects of technology advances (digital, physical biological) and the integration of them; (2) via the Internet, technological progress is rapidly spreading to all corners of the world at relatively low costs; and (3) the influences are abundantly broad to reach every aspect of human life.<sup>15</sup>

## The prominence of technological advancement in 4IR

Most technologies that will have a big impact on the world in five or ten years from now are already in limited use, while technologies that will reshape the world in less than fifteen years probably exist as laboratory prototypes.<sup>16</sup> Consider the possibilities of mobile devices connecting billions of people driving unparalleled processing power, storage capabilities and access to knowledge. In addition, the overwhelming convergence of emergent technology such as, among others, artificial intelligence (AI), robotics, the internet of things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage and quantum computing. Although many are still in early stages of development, they are already introducing an inflection point as they build on and amplify each other in a synthesis of technologies across the physical, digital and biological worlds.<sup>3</sup>

We subsequently find ourselves in an era of strategic complexity, characterised by uncertainty. Albeit that many considerations have been determined, their details and interrelationships remain unclear and dubious, and there might be other factors we have not even been considered yet.<sup>16</sup> Three broad conclusions become evident, namely (1) that humanity finds itself in a time of profound digital technological progress, (2) that there are potential benefits to be brought about by digital technology, and (3) that there are potential thorny challenges brought about by digitisation; emphasising that it should not be surprising, as “even the most beneficial developments have unpleasant consequences that must be managed.”<sup>17</sup>

Presently, technological transformation is changing practically every aspect of economic and social life.<sup>18</sup> Cyber-physical systems are at the core of Industry 4.0 – the convergence of hardware, software, and people to get work done, and, adding artificial intelligence (AI) and machine learning to the fusion, everything is transforming – from how factories are operated, to how services are rendered, to how people contribute to the economy.<sup>19</sup>

4IR is epitomising a “gravitational pull” set by multiple and complex drivers and crosscurrents, such as expanded globalisation, technological explosion, digital tools, Internet-centric data flow, and global competitiveness.<sup>4</sup> Klaus Schwab clustered technological megatrends into (1) physical (e.g. autonomous vehicles, 3D printing,



advanced robotics, new materials), (2) digital (e.g. IoT, radio frequency identification (RFID), Blockchain, Bitcoin), and (3) biological (e.g. genetic sequencing, synthetic biology, genetic modification / engineering / editing, 3D printing, embedded devices). The seemingly abstractness of these megatrends are obvious, but it nevertheless gives rise to practical applications and developments, as demonstrated by the discernment of the technological shifts below that are becoming mainstream and will shape the future digital world<sup>3</sup>:

Implantable Technologies

Our Digital Presence

Vision as the New Interface

Wearable Internet

Ubiquitous Computing

A Supercomputer in Your Pocket

Storage for All

The Internet of and for Things

The Connected Home

Smart Cities

Big Data for Decisions

Driverless Cars

Artificial Intelligence and Decision-Making

AI and White-Collar Jobs

Robotics and Services

Bitcoin and the Blockchain

The Sharing Economy

Governments and the Blockchain

3D Printing and Manufacturing

3D Printing and Human Health

3D Printing and Consumer Products

Designer Beings

Neurotechnologies

Although the detail of the technological shifts above, its positive and negative impacts are beyond the scope of this discussion, it is evident that 4IR is being driven by extreme automation and extreme connectivity.<sup>20</sup> However, because we as humans find meaning, to a large extent, in our careers and the contribution we make to the greater good through our jobs, a brief reflection on 4IR in relation to the world of work and the future of employment is justified. With these technological drivers transforming society, the question beckons: “how will the world of work and the future of employment be impacted?”

## 4IR and the future of work

The top ten effects of industry 4.0 on the workforce are reported as being (1) big-data driven quality control, (2) robot-assisted production, (3) self-driving logistic vehicles, (4) production line simulation, (5) smart supply network, (6) predictive maintenance, (7) machines as a service, (8) self-organising production, (9) additive manufacturing of complex parts, and (10) augmented work, maintenance, and service.<sup>21</sup>

The advances in artificial intelligence and robotics are approaching an inflection point where the historical correlation between technological progress and broad-based prosperity is likely to collapse unless the economic system adapts to the new reality.<sup>22</sup> Increasingly, machine algorithms are applied in intellectual tasks that were once the exclusive domain of humans, tasks that are retroactively redefined as “not requiring true intelligence”<sup>23</sup>, and both ends of the occupational spectrum (high- and low-end) are likely to be impacted as software automation and machine learning advances. The impact is already being felt in many professions, such as legal, paralegal and journalism, and emphasise that entry level positions are especially vulnerable.<sup>22</sup>

Although there’s never been a better time to be a worker with special skills or the right education, it is believed that the technological progress could leave many people behind, because computers, robots, and other digital technologies are acquiring ordinary skills and abilities at an extraordinary rate.<sup>17</sup>

A more optimistic argument is that technology, in fact, has led to overall job creation in the past. The direct effects are that technology substitutes labour, raising productivity and lowering prices, and sectors which are the source of technological innovation expand rapidly, demanding increased labour. The indirect effects are that technology complements labour, leading to improved outcomes in sectors which subsequently expand and generate new demand for labour, and lower costs of production and prices enable consumers to shift spending to more discretionary goods and services, generating new demand for labour.<sup>24</sup>

Conversely, there is the view that “AIs could become skilled economists and CEOs, guiding companies or countries with an intelligence no human could match. Already, relatively simple algorithms make more than half of stock trades; and humans barely understand how they work – what returns on investment could be expected from a superhuman AI let loose in the financial world? If an AI possessed any one of these skills – social abilities, technological development, economic ability – a superhuman level, it is quite likely that it would quickly come to dominate our world in one way or another.”<sup>23</sup>

Now, although senior managers are far from obsolete, machine learning is progressing at a rapid pace, and executives need to become adept in creating innovative new organisational forms needed to manage in an age of machine intelligence; accentuating creative abilities, leadership skills, and strategic thinking.<sup>25</sup>

## 4. Closing remarks

### Can we trust the predictions?

Predictions about the future development of 4IR are, however, as self-assured as they are diverse, and whether value can be extracted from the breadth and diversity of predictions is questioned. Expert judgement, in theory and in practice, and timeline predictions prove to be mostly unreliable, generally containing little useful information.<sup>26</sup>

### Whereto from here?

Considering these evident challenges and opportunities inherent to 4IR, Klaus Schwab calls for the mobilisation of the collective wisdom of people's minds, hearts and souls to adapt, shape and harness the potential of disruption. It is therefore conceivable that 4IR sets an important agenda for leaders in public and private sectors, academia and civil society, and the urgency of the matter is apparent on the micro-, mezzo- and macro domains (component parts of a general evolutionary analysis of coordination and change<sup>27</sup>).

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