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Moll, Ian

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AUTHOR:
Ian Moll[1]

AFFILIATION:
[1]Wits School of Education, University of the Witwatersrand, Johannesburg, South Africa

CORRESPONDENCE TO:
Ian Moll

EMAIL:
ian.moll@wits.ac.za

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Scientific revolution, industrial revolution, technological revolution or revolutionary technology? A rejoinder to Marwala and Ntlatlapa (S Afr J Sci. 2023;119(1/2))

Significance:

Critical responses by Marwala and Ntlatlapa challenged Moll's refutation of a contemporary technological revolution as a necessary but not sufficient stratum of a Fourth Industrial Revolution (S Afr J Sci. 2023;119(1/2)). This rejoinder suggests that they work with loose criteria about what counts as a 'revolution', and therefore confuse the character of industrial, scientific and technological revolutions. Therefore, their defence of the existence of a new, contemporary technological revolution, and a related economic, social and geopolitical revolution, rests on shaky conceptual ground. Neither the pandemic nor an unprecedented fusion of technologies has produced a 'Fourth Industrial Revolution'.

The Commentaries by Marwala[1] and Ntlatlapa[2] on my article[3] are welcome. One unfortunate consequence of 4IR-associated managerialism in universities is the stifling of critical academic debate. As the gigification of universities takes place, knowledge claims or research results are increasingly considered to be measurable performance units on digitised university rating scales. Robust debate of this kind is amongst the casualties.

Ntlatlapa is concerned that the title lacks precision: "[it] leaves the reader with the feeling that … a technological revolution is a fallacy". Of course, he is correct. When I formulated the title, I took it to be implicit that the 'technological revolution' it refers to is a nascent 21st-century technological revolution, a necessary but not sufficient component part of a 4IR. So the title of the article should be "Why there is no new, contemporary technological revolution, let alone a 'Fourth Industrial Revolution'". However, my argument remains that there is no 4IR, including a claim that there is no new, contemporary technological revolution.

Both Marwala and Ntlatlapa charge that to "dismiss [the 4IR] as by-product of these technological changes would be myopic"[1(p.2)]. I agree entirely. Indeed, I make it quite clear in the article that one cannot reduce an industrial revolution to a technological revolution: "An industrial revolution … is the fundamental transformation of every aspect of industrial society, including its geopolitical, cultural, macro-social, micro-social, economic *and technological* strata"[3(p.1)]. Most of my other writings on the 4IR are systematic demonstrations that there is no 4IR in broader social, cultural and geopolitical terms.[4-6] Growing global and national wealth divides, precarity of work for ordinary people, hollowing out of the middle classes, fragmentation of identity and culture, and marginalisation of the South by offshoring, outsourcing and 'onshoring back to the Cloud', are all sustained, deepening aspects of the 3IR. I repeat what I suggested in the article: "it appears increasingly clear that the 'brave new world' of the 4IR is not really happening"[3(p.1)].

However, the explicit delimitation of my article is that no grounds exist to claim that there is a technological revolution of the kind that would be a necessary part of a 4IR. Even though the technological, socioeconomic, sociopolitical and sociocultural mechanisms of an industrial revolution are functionally indivisible, it is quite legitimate to separate out any particular mechanism analytically. My focus on *technological revolution* here does not mean that I believe that an industrial revolution is purely technological. In suggesting this, both critics set my argument up as a straw person.

Ntlatlapa challenges my reading of Schwab and Marwala. Supposedly, I miss Schwab's emphasis in *The Fourth Industrial Revolution*[7] on "the confluence …[and] fusion of technologies. … any authors who challenge the notion of the 4IR as introduced by Schwab must use this as a basis"[2]. My response is twofold:

1. The question of technology convergence is addressed in the article, suggesting that Schwab's sense of a "staggering confluence of emerging technology breakthroughs"[7(p.8)] is overblown. I think that Marwala's talk of "unimaginably rapid, never-seen-before convergence"[8(p.9-10)] is equally exaggerated. Of course, this argument could be more detailed, but then, as now, there were space constraints. All that I can do here is commend Edgerton's demonstration that such "innovation-centric futurism" about technology convergences is historically misleading because it attempts to identify the fusion of new technologies at a single moment in time. In reality, "technologies appear, disappear and reappear, and mix and match across the centuries"[9(p.xii)]. For an extended discussion of this argument, see my *Debunking the Myth of the 4IR*.[6(p.43-51)]
2. Ntlatlapa's recognition that the article is "correct in so far as the technologies he [Moll] chose to analyse"[2(p.1)] is pleasing. At least this deals with popular rhetoric on the 4IR. However, there is a conceptual problem here: most of Schwab's exemplars purporting to ground his proclaimed 4IR – such as robotics and the Internet of Things – are convergences of technology. While they can be described at one level of a taxonomy as "individual advanced technologies", each is a fusion of digital (and sometimes other) technologies. Reading Schwab, one realises that most 'revolutionary' fusions of technology that he discusses could not be more mundane exemplars of digital technological changes in our society, as these examples illustrate:

- pet-tracking implants in human children[7(p.110)]
- "the internet of pipes … employ[ing] sensors in the water system to monitor flows"[7(p.75-76)]

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- a shirt that can measure breathing, sweating and heart rate[7(p.116)]
- a robot capable of "picking up a part, holding it in front of an inspection station and receiving a signal to place it in a 'good' or 'not good' pile"[7(p.142)]
- the first commercial drone deliveries[10(p.49)]
- the one terabyte SD memory card[10(p.50)]

One finds the same kind of examples in Marwala's *Closing the Gap*[8], whose '4IR' exemplars include the Mercedes-Benz app warning drivers of fatigue, Facebook notification apps, Instagram shopping features, online bank interest calculators, and the 'tap-and-go' payment facility on the Gautrain[6(p.51)]. None of these are more than current iterations of 3IR technology, more in the order of a gradual evolution of things. If one examines actual technologies discussed by Schwab and Marwala themselves, there is sparse evidence of a contemporary, socially pervasive fusion of new technologies that transcends the digital revolution in some way.

These slips in the meaning of 'technological revolution' suggest little precision in the ways that Marwala and Ntlatlapa use the term 'revolution'. Marwala, in particular, seems to operate with loose criteria for what counts as a revolution. He frequently proclaims that a 4IR is 'tangible' or 'demonstrable' when his only evidence is the existential sense that technology usage is on the rise and our lives are changing because of it. Clearly, this does not establish that there is a 4IR. The point, though, is that not all 'revolutions' are equivalent. The French and Soviet Revolutions, neither of which was an industrial revolution, were not the same kind of social transformation. The former is the archetypal bourgeois political revolution; the latter was, depending on one's perspective, a peasant revolution that established socialism or an armed insurrection that brought a reactionary political elite to power. Similarly, the putative South African 'rainbow revolution', the 'machine tools revolution'[11], the 'fluoride revolution' in toothpaste[12], and the 'ice cream revolution' in which we can choose "between hot fudge … and chunky monkey"[13], are qualitatively different kinds of social transformation. If they wish precisely to determine the existence of a 4IR clearly demarcated from the 3IR, both Marwala and Ntlatlapa need a more rigorous concept of the former qua *revolution*. It is not a matter of saying it looks or feels like a revolution, therefore it must be a 4IR.

This raises another crucial distinction that neither commentator notices, between 'technological revolution' and 'revolutionary technology'.[3(p.5)] Numerous revolutionary technologies appear in scientific research contexts. The article mentions the bionic hand, nanotechnology and autonomous vehicles. Marwala offers us quantum computing and interactive computational forms as examples (note that his 'intelligent automation' refers to the use by skilled people of combinations – not fusions – of digital technologies, not 'a technology' per se). The argument[3(p.4-5)] about why the first three are not technological revolutions is essentially the same for the latter two. Most contemporary quantum computing takes the form of analytic or simulation procedures *in research contexts*, because quantum computers are not widely available.[14] It sits within what Thomas Kuhn[15] terms the *normal science* of a paradigm, rather than a paradigm shift that ruptures the research context. Claims by quantum computing researchers (as opposed to 4IR prophets) are therefore cautionary.[6(p.40),16–18] Take for example this representative opinion in 2021: "research on quantum technologies [has been] performed for decades in [international] partnerships…to push these boundaries further, this collaboration needs to continue"[14(p.19)]. Likewise, interactive computational forms are 'revolutionary' only within research programmes, despite overcoming the limitations of discrete algorithms in modelling interactive systems.[19] For example, in research on autonomous vehicles, driving in traffic-free, geofenced areas can be modelled by discrete algorithms, whereas driving in traffic that "depends on incredibly complex, unpredictable on-line events [is not yet] algorithmically or sequentially describable"[18(p.317)]. Interactive computational forms operate within paradigms.

Marwala's view of the 4IR as a Kuhnian scientific revolution is not convincing, and requires further argument. He takes Kuhn's demarcation of paradigms to imply that "the technologies of the 4IR represent a scientific revolution in itself"[1(p.2)]. However, regarding the *development* of scientific knowledge, Kuhn emphasised *the priority of paradigms* over extended time: "Normal science…is a highly cumulative enterprise, eminently successful in its aim, the steady extension of the scope and precision of scientific knowledge [including scientifically informed technological innovations]"[15(p.52)]. One could just as easily appeal to Kuhn to justify 3IR continuity to the present, as to justify an assumed 4IR rupture. In any case, the comparison of an industrial revolution with a scientific revolution is more by way of analogy than identity: the former is an all-encompassing social transformation, whereas the latter is a response to anomalies within a research programme.

Marwala's contention that the 4IR is like an intelligence revolution is misleading: "We are anticipating that machine intelligence in this era will eventually exceed the intelligence of humans"[1(p.2)]. The history of the cognition-affect dialectic in cognitive psychology[20,21] reveals why this claim is probably wrong, and a deceptive framing of the current era of networked, digital technology. On the one hand, machines have long surpassed the mechanical and computational aspects of our cognition. Adding machines already achieved this in the early 1900s. We routinely offload cognitive tasks onto computers, and there is nothing particularly distinctive about a supposed 4IR in this regard. On the other hand, it seems that even sophisticated computers are incapable of *common sense*, that crucial aspect of cognition that grounds us emotionally in the world[22]: "people are smarter than today's computers because the brain employs a basic computational architecture that is more suited to deal with [this] central aspect of the natural information processing tasks that people are so good at"[23(p.3)].

Finally, a word is necessary about the now tired claim that COVID-19 has accelerated the 4IR. Marwala suggests this is sufficient proof that there is a 4IR. Of course, there is a correlation between the pandemic and the increased use of digitally networked ICTs in government, business and education. The claim that it 'accelerated' the use of digital technology is now a truism. However, the often-repeated claim that the pandemic accelerated a 4IR is simply ideology.

In response to Marwala's and Ntlatlapa's challenges, I suggest the following in this rejoinder. First, there is no clear 'demarcation' that marks the end of the 3IR and a nascent 4IR. Second, the fact that the pandemic hastened the adoption of digital technologies does not warrant a claim that there is a 4IR, nor indeed an attendant technological revolution. Third, it is precisely a careful analysis of Schwab's arguments about a "fusion of technologies across the digital, physical and biological worlds" that leads us to skepticism about a so-called 4IR. We need to modify Marwala's final sentence – we are in the age of the ideology of the 4IR, but there is no associated technological revolution, nor indeed any industrial revolution, to speak of.

Competing interests

I have no competing interests to declare.

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