



# Leapfrogging

## Introduction and background

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Leapfrogging is a well-established phenomenon in human history. It was originally associated with the wheel, the plough, the printing press and the steam engine, each accompanied by unthinkable shifts in productivity. It is the story of technological innovation in one place that, once copied by others, allows the latecomers to leapfrog as they can sweep aside the old, outdated technologies through a process often described as creative destruction. Such as when the printing press defeated the handwriting duplicators of books, the horse-drawn carriage by the car, the mechanical typewriter by the personal computer and today, the writing of most software and much reportage by artificial intelligence (AI). Progress today is much more rapid, but all of it requires access to electricity and the Internet—both currently in short supply in Africa but gearing for rapid expansion.

What distinguishes the 21st century from previous periods is the exponential rate at which scientific knowledge is advancing and our ability to translate that knowledge into practical application. Each new generation of technology stands on the shoulders of its predecessors, and today the rate of progress from version to version is driving advancement at breakneck speed. Two examples suffice: first, the speed at which vaccines were developed for COVID-19 and now progressing to oral antiviral medicines, and second, the explosion of AI applications in the wake of the release of Chat GTP. Still, it is always important to remember that what is technologically possible is not always commercially feasible.

While much leading-edge technological progress may occur in high-income countries, uptake and social effect are often more readily seen in developing countries.

The theme on [health and associated WaSH](#) infrastructure provides an overview of the extent to which Africa trails in basic infrastructure such as potable water and waterborne sanitation. The story is, of course, much broader. Africa trails in every dimension of infrastructure, with the largest deficits being the lack of reliable electricity and transport, particularly roads, rail and suchlike. We discuss the impact of [larger infrastructure projects](#) in Africa, such as rail, airports and ports, in a separate theme (but include the impact as part of the combined Leapfrogging and Large Infrastructure scenario below).

Once a country has invested in and built an elaborate network of railway lines, pipes, wires, roads, bridges, buildings and other expensive physical infrastructure, which is characteristic of today's developed countries, it becomes very difficult to imagine or to take the risk of investing in a different way of doing things. Every piece of existing infrastructure creates vested interests that are subsequently difficult to uproot. The result is a tendency towards 'path dependency', where governments and the private sector do things in a particular manner because that seems to be how things should be done and because it is difficult to get the public to change their ways and to undo sunk investments.

Consider, for example, the extent to which production and consumption subsidies have locked the world into its current carbon-intensive development pathway. According to one estimate, governments worldwide pour around half a trillion dollars annually into subsidising [fossil fuels](#)—more than triple what renewables receive.

At a sufficient scale, future technology could compete with traditional infrastructure such as road and rail. Consider, for example, bulk delivery systems via thousands of heavy-lift drones that can move directly from point to point - mass transportation systems that don't require asphalt roads and that could replace trucks, trains, cars and buses. Already, the partnership between drone manufacturer [Zipline](#) (launched in Rwanda in 2016 doing blood deliveries) and [Walmart](#) opened up the potential for the delivery of purchases from a central logistic hub (national air regulation allowing) for on-demand deliveries of select health and wellness products with the potential to expand to general merchandise. Operating from a Walmart store, Zipline can service an 80 km radius. In 2020, Zipline was provided emergency permission in the US to fly long-range delivery drones in the US with its highly regulated air space and then later that year, also at night. In 2021, the company signed partnerships with the Cross River and Kaduna States in Nigeria and closed an agreement capable of serving 90% of Ghana's population.

At some point, it may be possible to fly in a unit able to undertake layered fabrication ([contour crafting](#)) similar to [3D printing](#) for rapid construction in a remote location where the unit will use local soils and compacting materials to print houses and other structures. It could source water from humidity in the air and its energy requirements from wind and thermal, then rapidly charge powerful and lightweight batteries. Or it could use that energy to produce [hydrogen](#) from water that can then be used as an energy source for heavy-duty work. The subsequent structure could be designed as a stand-alone system that limits waste and pollution, keeps products and materials in use and regenerates the natural system. These are three principles required for the transformation to a circular economy where waste is used as biomass, and it is independent of the need to be connected to bulk services such as water, electricity and waterborne sewage. The ability to remove deadly bacteria such as [E. coli](#) from water would, on its own, significantly improve the rapid treatment of large volumes of water and can be integrated into current solar water disinfection technology in countries with limited access to fresh water or where piped water connections are impractical.

The 2008 financial crisis provided a huge boost to cloud computing. A decade later, COVID-19 accelerated new technologies for vaccine development, the expansion of digital and e-commerce sectors and remote work.

The long-term impact of modern technology is likely greater independence and more choice but with the potential to deepen inequality since it generally requires access to electricity, stable, high-speed Internet, a smartphone, tablet or computer and funds to maintain access. The essential challenge within the dominant competitive economic and global context is harnessing technology to serve the global good.

Recently much attention has been paid to the potential contribution of AI.

AI can help understand how the universe works, make better and faster diagnoses for humans, and implement automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes. Similarly, AI's application in data security, education, agriculture, robotics, entertainment and other aspect of life will make life easier for people. For example, the [Africa Regional Data Cube](#) (ARDC) layers 17 years of satellite imagery and Earth Observations data for five African countries (Kenya, Senegal, Sierra Leone, Tanzania and Ghana). It stacks 8 000 scenes across a time series. It makes the compressed, geocoded and analysis-ready data accessible via an online user interface, helping law enforcement identify and track illegal mining operations in Ghana.

While [AI adoption](#) has been concentrated in the Global North, effective adoption and implementation in Africa are dependent on a host of factors. They include a local workforce with the required training to develop these solutions, sufficient infrastructural capacity to handle the computationally heavy training of algorithms, representative datasets, governmental support and regulation to govern the appropriate fair use of these technologies, and independent and civil institutions and policymakers that safeguard from harmful applications and reinforce responsibility and accountability.

In time, AI may also have a globally transformative impact. An example of such impact is how the US shale oil and gas revolution reshaped the global energy market and global politics.

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Dr Jakkie Cilliers is the ISS's founder and former executive director of the ISS. He currently serves as chair of the ISS Board of Trustees and head of the African Futures and Innovation (AFI) programme at the Pretoria office of the ISS. His 2017 best-seller *Fate of the Nation* addresses South Africa's futures from political, economic and social perspectives. His three most recent books, *Africa First! Igniting a Growth Revolution* (March 2020), *The Future of Africa: Challenges and Opportunities* (April 2021), and *Africa Tomorrow: Pathways to Prosperity* (June 2022) take a rigorous look at the continent as a whole.

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