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P. MORSE, Aspen Technology, Houston, Texas

# Black swans and gray rhinos: Building future resilience

These are extraordinary days as we collectively work to contain the COVID-19 virus. Each day we learn about varied efforts across the globe to prepare communities and economies for potential illness, even as it impacts local employment and business activity.

This is truly a black swan moment—an event that we could not have predicted and has profound impact on our lives and businesses. Many business analysts and economists have been forced to define new metrics and re-draw axes on existing charts to capture this moment.

During this chaos, the gray rhinos—an important future risk that may be generally ignored despite the potential for harm—must not be forgotten. For chemical and energy companies, sustainability is a gray rhino. As all companies have been challenged by the current economic and health crisis, the successful recovery requires a new view toward future development and growth with metrics that consider broad and more long-term goals.

The importance of this effort has not been forgotten by investors, with Black Rock reminding companies that sustainability commitments will remain criteria for future investment.[1] Several companies have also reaffirmed sustainability targets—including Shell, BP and Dow—as the current crisis reminds investors that external risks can be a real threat.

Digitalization is a crucial enabler for companies to meet both business and sustainability objectives. The International Energy Agency (IEA) has found that digital solutions can help boost energy efficiency as much as 30% for industrial operations.[2] In Europe, the Technology Platform for Sustainable Chemistry has highlighted digitalization as a key tool to meet sustainability objectives.[3]

Digital tools have targeted sustainability-related objectives for decades, mainly focusing on energy efficiency, pollution control and value chain optimization. Traditionally, cost savings drove much of the efficiency efforts, but companies are increasingly focusing on waste and discharge reduction from production units, as well as efficiency enhancement through digital solutions. They are exploring new energy sources with lower carbon footprints, and new products that better fit the circular economy.

These solutions provide the visibility, analysis and insight needed to address the challenges inherent in sustainability goals. Success begins by harnessing the voluminous data available—applying new technologies, such as artificial intelligence (AI)—to control operations and empower operators to make the decisions that will achieve their multiple objectives of customer satisfaction, societal sustainability and business profit.

**Achieving safety and reliability.** With the use of digital technologies, project engineers can design for process safety from the beginning, delivering optimal designs that comply with industry safety standards. Integrated system analysis can generate comprehensive plans for critical systems, such as pressure relief and flares across the plant and the entire complex. New dynamic modeling capabilities enable upgrades of existing flare and pressure safety valves, as they integrate to create a more accurate model of operations.

Monitoring and control technologies work to continuously optimize unit operations to stay within safety limits and alert for equipment failure and process degradation that can lead to unexpected incidents. The same models that have enabled better design and operations are also useful tools to prepare new operators to manage unexpected process upsets that often lead to safety incidents. Operator training systems using digital twins of current and future operations are becoming the standard training practice across the industry.

Notable success stories include the use of dynamic modeling by Chiyoda Corp. to enable faster startup of LNG operations, while ensuring critical safety standards are met. In a low-density polyethylene process, one European-based producer received 27 d of warning for a central valve failure and avoided an unplanned shutdown and potential related flaring and emissions release.

**Reducing environmental impact.** Digital solutions can provide guidance on environmental impact throughout initial project planning and operating processes, and even give insight into maintenance activities to help avoid equipment breakdowns, including the emissions and dangerous conditions that often accompany them.

Companies can use a digital simulation of production processes, typically called a digital twin, to determine the best process and equipment selection for energy efficiency and reduced emissions of carbon dioxide ($CO_2$) and other pollutants and greenhouse gases. After construction, these same models are used to improve operations by adjusting to feedstock and operational variations to ensure efficient resource and energy use. Process control capabilities help stabilize operations to optimize energy use, extending this analysis across the entire supply chain.

When processes do not run as expected, digital technologies can provide insight and avoidance measures. AI gives companies advance warning of potential breakdowns so they can avoid dangerous conditions, reduce the amount of effluents released into the environment and minimize maintenance costs. For complex processes, multivariate analytics take a broad view of

many process variables to identify those that are critical to reduce off-spec production and reduce waste.

Advanced technology solutions have enabled many companies to deliver improved environmental performance including Kuwait National Petroleum Company (KNPC), which reduced energy use in its refineries by $15 MM/yr and optimized energy sourcing to increase energy efficiency and reduce carbon footprint. Petrochemical producer Braskem has used advanced process control to lower the energy consumption of an ethylene unit by 20%.

**Driving efficiency and innovation.** The desire to make significant strides toward sustainability targets will drive many companies to fundamentally change their energy sources and shift product portfolios. This transition will take time and will require substantial investment in new technologies. However, the potential payoff is significant, with an estimated $1 T in new business opportunities available.[4]

Digital technologies are enabling companies to increase the efficiency of their operations and more quickly develop solutions to solve the challenges of the circular economy. The solutions focus primarily on emissions associated with energy use, such as $CO_2$ and nitrous oxide ($NO_x$), in addition to a move toward the use of alternative energy sources.

Digital twin capabilities give companies a comprehensive view of energy use across a unit or enterprise, and new visualization tools enable better analysis and reporting of the overall and discrete energy consumption. Specific modeling of process energy can also identify potential energy saving opportunities between units and throughout the complex.

A new emphasis emerging in the industry is "decarbonization," or the reduction of the carbon footprint of a process or energy source. These efforts target a reduction in carbon emissions associated with a process—for example, using a lower-carbon fuel like natural gas instead of coal, or substituting wind or solar energy or renewable biomass for a fossil fuel. Digital solutions aid these efforts by modeling and comparing alternative processes for various metrics, such as cost, emissions of $CO_2$ and other greenhouse gases for the energy delivery.

Simulations can efficiently screen alternative energy sources and new process routes, while accounting for associated emissions and resource demand for each. Early efforts are underway to apply modeling technology to improve the efficiency of processes based on new energy feedstocks, such as biomass and plastics waste.

Concern about growing volumes of plastic waste worldwide has raised the urgency of moving toward a circular economy, where materials are reused after initial application so fewer natural resources are consumed overall. Some companies are pursuing depolymerization processes to deconstruct the plastics back to their base raw materials—an approach often referred to as molecular or chemical recycling—allowing for the same high-quality product to be produced again.

However, most of these processes are inefficient and can currently only be executed on a small scale. They will need further development to be competitive solutions for the global market, and modeling software is an important tool to boost the speed and efficiency of these experiments and to optimize commercial processes.

Water productivity is another important component of the circular economy and can be improved using process optimization and improved control. Companies are using modeling to improve water efficiency in processing, along with the economic assessment of water treatment and desalination projects. In addition, process monitoring has enabled leak identification in high-water-demand processes, such as oil sands extraction and mining.

Abu Dhabi National Oil Co. (ADNOC) was successful in using a digital twin of existing oil and gas operations in the Middle East to capture efficiency opportunities and optimize implementation, cutting water use by 10% and energy use by 5%.

The integration of sustainability targets with business goals will be transformational for energy and chemical companies, as well as businesses across industries. Global efforts to move toward new energy sources and the circular economy will drive a strategic shift in business metrics and the practices that will enable success. Many forward-looking companies have already begun this process, investing to build new capabilities and developing innovative technologies and business models to achieve new targets.

Achieving the fragile balance of sustainability goals—equally considering people, planet and profit—is a considerable challenge, but one that must be addressed to be competitive in the energy and chemical markets of today and tomorrow. During this period of market and economic recovery, a renewed focus on these goals will enable longer-term resilience for successful companies. HP

**LITERATURE CITED**


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**PAIGE MARIE MORSE** is the Industry Marketing Director for Chemicals at Aspen Technology. She has significant experience with leading operating companies, including Shell, Dow, Sunoco and Clariant, particularly in R&D, marketing, commercial and strategy roles. Dr. Morse earned a BA degree in chemistry from Kenyon College and a PhD in chemistry from the University of Illinois.





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