

HOW BUILDING A DIGITAL BIOTECH IS MISSION-CRITICAL TO MODERNA

INTRODUCTION

We are living in a unique time in which the world is changing faster than ever. This largely is due to an influx and infusion of digital technologies that are reinventing and reimagining businesses across nearly every sector, and dramatically shifting societal and economic interactions. While the life science industry has, to some extent, adopted various digital technologies, it has not had a significant digital transformation in how it does business.

Most life science companies were in existence before the digital age, so they have the daunting task of integrating digital solutions with complex business and organizational structures and with legacy technology. In addition, the nature of those companies' R&D and manufacturing is quite heterogeneous. The companies comprise a medley of scientific and drug technology platforms across and even within therapeutic areas, hindering opportunities to digitally transform the business.

For younger emerging biotech companies 'growing up' in the digital age, incorporating digital technologies may not be as arduous a task. However, becoming fully digital is both an expensive and deliberate prospect. With corporate and R&D projects vying for resources, heavy investments in digital initiatives may fall low on the priority list. Moreover, most emerging companies are advancing just a handful of drugs in their pipeline and typically doing so in a sequential fashion. So, the need to integrate multiple R&D and/or commercial programs is not a paramount or even a relevant concern.

AT MODERNA, BUILDING A DIGITAL BIOTECH IS A FOUNDATIONAL COMPONENT OF WHO WE ARE AND A KEY ENABLER OF WHAT WE ARE TRYING TO ACCOMPLISH.

The "why" for Moderna starts with our mission: *Deliver on the promise of messenger RNA, or mRNA, science to create a new generation of innovative medicines for patients.*

Our mRNA medicines are derived from our core mRNA platform technology and, hence, all fundamentally work the same way to elicit a similar end result; they direct cells in the body to make proteins to prevent or fight disease.

Our strategy at Moderna is focused on advancing mRNA medicines across many therapeutic areas and diseases simultaneously using mRNA as a medicine. Broadly exploring the potential of our mRNA technology to address many diseases simultaneously requires a digital model that deeply transforms how we design and manufacture medicines.

This model elicits a cycle of continuous data generation, analysis and learnings, which in turn, inform and accelerate future R&D efforts. We are seeing this on two levels:

The first is within modalities. For example, within the prophylactic vaccines modality, there is research underway at Moderna, Merck, NIH and other collaborators. Scientists take learnings and data readouts from preclinical experiments, GLP toxicology studies and clinical results to make ongoing and future efforts move faster, with higher quality and less risk.

The second is between and among modalities. Scientists

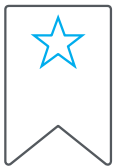
across the ecosystem have access to real-time data and information; learnings in one therapeutic area often are reapplied to another therapeutic area.

We rely on digitization to ensure seamless integration across the ecosystem, the ability to share and access data and the capability to scale and satisfy an ever-increasing demand for research mRNA for preclinical and GLP toxicology studies, as well as GMP mRNA to supply an expanding number of clinical studies.

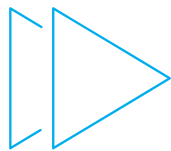
Enabling a 20-year innovation cycle

We believe we are at the beginning of a 20-year mRNA

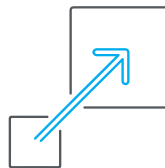
Benefits of Digitization



QUALITY: Reduce human errors by enabling automation, repeatability and seamless integration wherever possible.



SPEED: Provide large quantities of mRNA across the ecosystem in a rapid timeframe to permit the acceleration of rational mRNA drug design and to gather, analyze and share data in real time to inform decision making.



SCALABILITY: Accommodate an ever-increasing number of mRNA R&D programs within and across modalities.



COST: Create an infrastructure that can be leveraged across all R&D programs to maximize efficiencies.

Digitization Building Blocks

1) Cloud enablement is a must-have component of our digital infrastructure. Our science is rich in complex data sets, and our scientists need computational power, agility to operate, cost effectiveness and efficiencies in organizing and processing data without being hindered by the limitations of traditional computing technology.

2) Integration includes looking for every opportunity to bring our processes and data together in a consistent manner, avoiding 'silos of information' and manual intervention. This flow of data between systems, internally and/or externally, enables the automation of our business processes and the real-time synchronization of our operations. Many companies struggle due to legacy systems, siloed data and processes and inherent inefficiencies. To that end, as we grow, we have been organizing and managing our data around systems of records. These data are then shared and synchronized, enabling real-time data correlations and other learnings.

3) Internet of Things is based on smart, interconnected devices producing information about their environments and operations. This immense new source of data from instruments and environments provides real-time guidance

innovation cycle that most technologies go through before their performance has been optimized. We hope to find early successes and advance ongoing improvements to the technology that will permit an ever-greater number of opportunities as we invest in the platform.

Achieving success involves several factors, including learning the fastest and scaling rapidly, all while maintaining the highest quality. The only way to ensure this will happen is through digitization. **Since Moderna's inception, we have invested over \$100 million on our digital technologies, robotics/automation, analytics, data science and AI.** Given our growth, we expect we will invest more than \$100 million in digital over the next 5 years.

to our scientist and engineers and helps us in supply chain and manufacturing with compliance and traceability, including tracking material, controlling inventory and optimizing instrument usage.

4) Automation is radically transforming businesses and driving a new technology-driven revolution worldwide. With the help of robotics, we reach an unprecedented level of automation that increases our operations' accuracy, repeatability and throughput, and reduces human errors, dramatically improving our quality and compliance.

5) Analytics are necessary to harness the power of our data. Using the latest tools and analytical methods, we have designed an environment that enables us to undertake any kind of analysis. Having rich and complex data readily available enhances our capability to generate scientific and business insights to make informed decisions.

6) Artificial Intelligence (AI) is enabling key breakthroughs in analytics and predictive modeling that helps accelerate our learning cycle drastically, providing us with critical insights into research and production data that were otherwise inaccessible and unachievable.

OUR DIGITIZATION STRATEGY

OUR BUSINESS STRATEGY is to advance a broad array of mRNA medicines for many diseases simultaneously to deliver on the promise of mRNA science for patients as quickly as possible. Central to this strategy is the enablement of parallel progress and shared learning, by virtue of a digital infrastructure, **built from the ground up**, that exploits the inherent replicability of mRNA and its software-like features. As a result, scientists at Moderna and our collaborators are progressing dozens of mRNA R&D programs concurrently.

Our digital team works closely with their business counterparts, defining a digital way of operating that reduces unnecessary process complexity, uses AI to augment our analytics, and incorporating automation. We designed systems from the ground up to use cloud services and to integrate seamlessly. We organize and manage our data around systems of records with related data sets, that are then shared and synchronized to enable real-time utilization.

We have two core “engines”, highly adapted to the unique

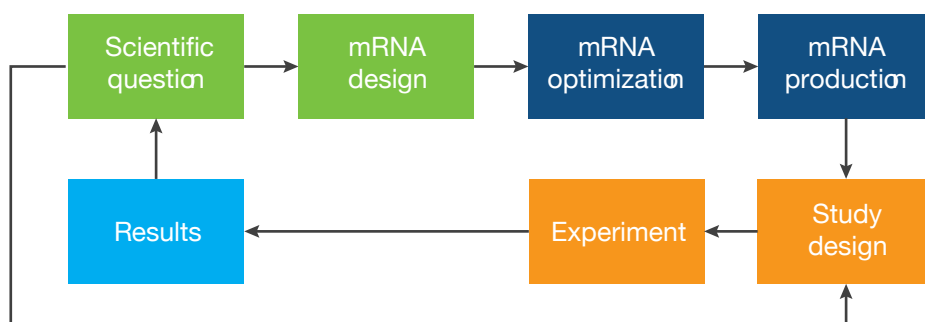
needs of our technical and scientific efforts – our Research Engine and our Early Development Engine.

Our Research Engine is designed to move many mRNA research programs simultaneously from concept to development candidate nomination. Our Early Development Engine then advances development candidates through clinical studies to human proof-of-concept. Each has unique requirements as well as the need for continuity between the two engines, we utilize both internally developed software and algorithms and standard off-the-shelf solutions. Internal software and algorithms support the high need for specificity and differentiation in research as well as the frequent changes that require short delivery cycles. Off-the-shelf solutions, including innovative emerging technologies, are then integrated to ensure seamless business processes.

RESEARCH ENGINE DIGITIZATION

OUR SCIENTIFIC DIGITAL ENVIRONMENT prioritizes two goals, the rational design of mRNA medicines and the acceleration of programs through research.

Research Schematic



Designing and Ordering mRNA

Our scientists turn ideas into mRNA designs using a suite of tools called the Drug Design Studio (DDS). DDS contains a sequence design app that allows scientists to build novel mRNA sequences using a library of existing sequence components or ones they import. Embedded AI algorithms convert amino acid sequences into nucleotide sequences and optimize a sequence for production.

Our existing algorithms use heuristics learned from years of accumulated knowledge around the interactions of mRNA sequence with both production yields and protein

expression. Our next generation mRNA and protein design algorithms use neural networks to incorporate large public datasets with our proprietary data to find emergent relationships to improve our mRNA performance.

Once designed, mRNA is sent to our Preclinical Production team using the DDS Ordering app, which configures the ideal properties for both mRNA and formulations. DDS Ordering automatically performs several AI sequence quality checks and optimizations before sending the order to Preclinical Production.

Producing Preclinical mRNA

mRNA production is triggered in our Preclinical Production app. The app coordinates every step of the production process, from the initial creation of the DNA plasmid template to the final formulated mRNA. Full automation has taken the place of manual work when it comes to liquid handling, production and quality controls.

The tight integration of the instruments with the Preclinical Production app and our external vendors allows us to capture and interpret data at every step of the process, with full digital traceability for each mRNA construct.

Our real-time algorithms and analytics tools embedded in the app also drive our quality control process and our continuous improvement process. As an example, a logistic regression machine learning algorithm trained on historical data predicts which mRNA orders are at risk of producing insufficient material and restart them early to save time. A rules-based algorithm also optimizes partial container selection when choosing raw materials for efficiency.

One of our more advanced AI implementations in Preclinical Production is for automated Sanger sequencing analysis. Sanger sequencing is used repeatedly to QC our DNA templates and final mRNA; while the data contain every nucleotide in a sequence, it is very complex to analyze. A fully automated data pipeline starts processing raw data the moment it is saved to the cloud by the sequencers. The pipeline spawns numerous AWS computer servers to run an analysis algorithm and then shuts the servers down, resulting in minimal costs. The results are viewable in a powerful, dynamic visualization tool. To date, we've run over 3 million Sanger data files through this system.

Using vast amounts of internal data, we have further improved our Sanger analysis with a convolutional neural network (CNN) to better analyze the tail sections of mRNA. These long polyA stretches convolute the Sanger data and make analysis difficult. We trained a CNN on over 20,000 labeled data files generated from expert operators, which now immediately returns a pass/fail score that exceeds individual human performance. This algorithm increases the consistency and quality of our mRNA and saves countless hours of manual human analysis.

We've also leveraged our data to rebuild the Sanger analysis algorithm from the ground up. The original analysis was based on an off-the-shelf algorithm, with some modifications by Moderna. While this algorithm has been a standard tool in the industry for 20 years, we found it was often missing subtle failure modes, such as when only a subset of samples has a mutation. This results in lower quality and more manual reviews. Our solution was to start from a blank page and build an entirely new algorithm from the ground up using a variety of Bayesian inference techniques. The new Moderna-created algorithm shows consistent accuracy for pure samples but also catches these other more challenging

failure modes that the old one missed. The new algorithm is also intuitive and extensible but requires 100x the computing power. However, with our modern cloud infrastructure we can access this computational power easily.

The extensive robotic automation and AI in our preclinical-scale mRNA production contributes dramatically to reducing our cycle time, increasing our throughput, and helping us deliver consistent, high quality mRNA at the lowest possible cost.

Dispatching and Shipping mRNA

Our Shipping app automates dispatching and shipping of mRNA for internal use and to external partners globally. The app is also used to coordinate biological sample shipments from *in vivo/vitro* studies to teams who prepare and analyze them. The app produces the appropriate labels and customs forms and drives the shipment and receiving with a click of a button or tap on a smartphone. The app also generates real-time notifications on shipment status to all parties.

Inventory and Registry

Every material used and created in research and in preclinical production is tracked in the Inventory app. This includes mRNA, animal tissues, cell lines, chemicals, reagents, and much more. The app has numerous workflow tools like consumption, aliquoting, material transfer and stock alerts.

Critical material types are also assigned unique registry IDs by our Registry app, for every type of unique material with which Moderna's systems interact. Unique IDs, used all through the research and development of an mRNA and its components, allow systems and processes (including offline processes) to ensure they are all referring to the same material.

Study Design

To design *in vivo* and *in vitro* studies, our scientists use our In Vivo and In Vitro Study apps. Once a study is registered, the Study apps help scientists plan their study, order mRNA constructs and track progress.

The integration of the Study apps with our production and *in vivo* planning tools provides scientists with immediate visibility to the availability of the resources they require for their experiment, real-time progress report and improvement suggestions. The goal is to optimize overall study outcomes, resources and cycle time.

The Study apps capture varied and complex *in vivo* and *in vitro* study protocol designs—including all necessary doses, samples, assays, etc. – and generate a precise plan for study activities that the operations team executes.

Experiment Management

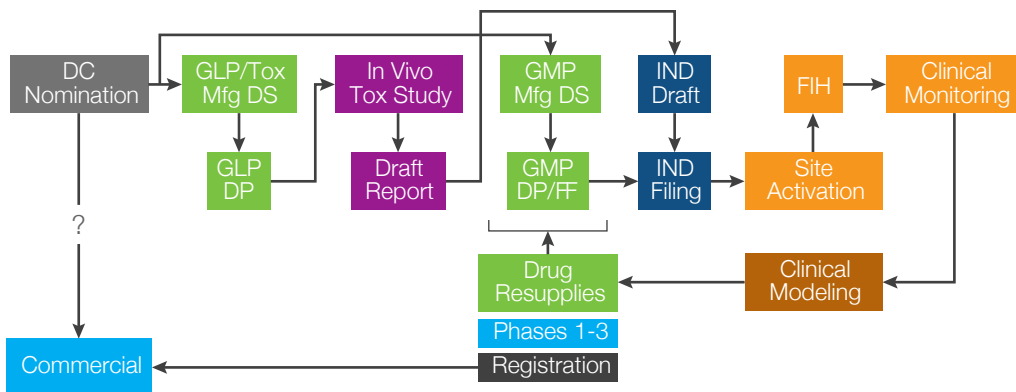
We have deployed electronic lab notebooks to streamline and track experiments in a standardized, searchable repository. We chose IDBS' new web-based E-Workbook electronic lab notebook because of its modern design,

simplicity, usability, workflow capabilities, e-signature and reporting. We are also working to integrate it further to connect Inventory, Studies, and instrument data directly with the notebook. Our scientists' data management has become 'smarter,' with information they can trust, accelerating their ability to make decisions, share and collaborate.

EARLY DEVELOPMENT ENGINE DIGITIZATION

OUR EARLY DEVELOPMENT PROCESS starts when we nominate a development candidate (DC) that we intend to progress to IND and clinical trials. This process from start to finish, without exception, has been digitized. Our DC approval workflow from candidate selection to DC nomination allows us to review the data and electronically approve the DC. Once approved, the DC's attributes and data are tightly controlled. From this point forward digitization focuses on driving the clinical and operations process, solving for quality, safety, time and cost, making sure the DC remains on track to reach the next development milestone.

Clinical Development and Operations Process (C&OP)



Technical Development

Technical development requires a broad spectrum of digital capabilities including electronic notebooks, structured data capture, integrated equipment and high throughput testing. Our strategy incorporates data integrity and knowledge management with speed of execution and time-to-insight, using a blend of off-the-shelf and custom software.

Process Development

Novel experimentation and characterization work is captured in our electronic lab notebook and tagged with attributes to organize our process learnings. Process experimentation is modeled in our proprietary platform editing software and allows us to create structured experiments, which are then executed in our custom Development Hub software which interlinks all sample testing requests, inventory management and key process equipment to support analytics for rapid insights.

Analytical Development

Early stage analytical development is performed using off-the-shelf analytical software and the data and outcomes are

stored in our electronic lab notebook. Whenever possible we leverage the same systems between Analytical Development and Quality Control to accelerate the transfer of testing methods to production. This includes a shared, cloud based HPLC management system and integrated laboratory execution system. High throughput testing to support rapid decision making on process experiments is performed using integrated robotics and high-throughput test methods.

Pilot Operations and Technology Transfer

Pilot operations produces material for toxicology studies and when possible leverages the same equipment and processes to help ease the transfer into GMP operations. Execution is being implemented in our Development Hub software and equipment is integrated with our process historian which allows us to compare data sets with GMP operations. Data to support technology transfer is generated in structured reports and our platform editor software can be used to automate transfer reports and generate an electronic batch record design.

Clinical Development

As we began nominating DCs from our preclinical pipeline, efficiently managing the portfolio became a top priority. Our Clinical and Operations Planning (C&OP) process digitization is designed to help plan resources and track the execution of each DC from nomination through its various clinical trial phases, with a suite of apps that provides a 360 degree view of all the steps: regulatory filing, GLP Tox/ GMP manufacturing, in vivo toxicology studies and clinical scheduling.

IMO

The IMO app enables the program leads in our Investigational Medicines Office to plan the development of their DCs. Program leads input Clinical Development Plans (CDPs) which detail the timing of studies, cohort sizes, dose levels, etc., which are then integrated with other systems. Data are used to drive the demand signal for other functions in Moderna and corresponding supply dates are digitally returned by function.

Supply

The Supply app captures the manufacturing demand generated by the IMO and helps manage and track the supply of GMP and GLP Tox material. The app is integrated with our ERP and helps the supply chain team plan manufacturing batches with a single view of the supply plan to support manufacturing operations. In addition, the app contains manufacturing schedule changes over time, supply/ demand mismatches, simulation & forecasting capabilities, while enabling cost projections and resource planning with real-time alerts.

Regulatory

The Regulatory app tracks and synchronizes filing dates from pre-IND meetings to IND submission to Safe to Proceed notices. It auto-generates a schedule based on milestones set in the IMO app and highlights mismatches.

Toxicology

The Toxicology app plans and tracks in vivo toxicology studies, important milestones that must be met before a new product may move to the clinic. The app ensures that study time slots with our external vendor are available and that the GLP material needed is received on time. The app is integrated with the IMO app to get up to date clinical demand timelines and manufacturing supply timelines, to enable rapid response to changes.

The C&OP suite captures and plans all key milestones out to BLA submission, enabling better forecasting of supply and demand through the organization. New advancements will forecast more accurate drug supply requirements, taking into account product/process details, clinical trial design, drug expiry, and live trial enrollment. We expect to integrate

this system directly to our ERP for rapid resource planning.

Clinical Operations

Efficient and high-quality execution of clinical trials is of the utmost importance for Moderna.

We have digitized the collection of clinical trial documentation using Veeva's eTMF system. This system provides a single, central location for critical trial documentation across all of our studies.

For clinical data collection, we've standardized on the Medidata suite of products. Medidata is the market leading Electronic Data Capture (EDC) provider. Medidata provides an integrated suite of tools for patient diaries, statistical analysis, protocol optimization, and patient consent, which we leverage as needed. With a single, centralized EDC provider, we can standardize our data collection, with cost savings and more rapid study builds and analyses.

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We have standardized on endpoint Clinical's IRT system for clinical drug supply and randomization. This user-friendly tool is critical for ensuring sites and patients receive their medication. The IRT is integrated to the EDC system in all of our studies to allow data to flow seamlessly.

Finally, clinical trial status monitoring is achieved with a proprietary Clinical Metrics app that integrates with the clinical trial management systems of our CROs to pull in data on patient enrollment, site activation, and many other metrics. This app serves as a standardized and centralized view of our portfolio of studies.

Regulatory Filing and Compliance

For regulatory filings and inspections, the Veeva suite of applications provides regulatory information management capability for document submission and archiving, enabling real-time inspection readiness, visibility and control. This suite is used as the "single source of truth" for all regulatory exchanges.

GMP Manufacturing & Quality Control

In 2018, we launched our fully-digital manufacturing site in Norwood, MA. The site was designed to be fully integrated and paperless without silos of legacy systems or data. The digital design is centered around our operators to accelerate execution, improve quality and allow the site to scale rapidly while maintaining flexibility. Rather than using product-specific records, processes and equipment like traditional pharma companies, our platform enables us to

build product-agnostic building blocks and parametrized manufacturing recipes. Within our qualified digital systems, this design allows us to implement digital changes required to support a new product in only a few days.

In Norwood, greater than 90% of operations are controlled from the cloud. Balancing resiliency with limited on-site computing gives us a template to deploy additional sites in the future faster with lower capital investment. The digital investments have delivered measurable savings in operations and these savings are compounded with each new product we produce.

Integrated Electronic Batch Records - Equipment Use

Integrated electronic batch records instruct operators which equipment to use, verify the equipment is ready for use, control operations on the equipment and collect and analyze the equipment data in-real time.

Integrated Electronic Batch Records - Raw Materials

Integrated electronic batch records instruct operators which raw materials to use through a real-time integration with the SAP system. Barcoded materials are scanned, mixed and charged to ensure accurate inventory controls. Produced product intermediates are tracked and stored through digital controls. Buffers are produced to inventory using fully automated tanks and mixing processes. Using iris ports, buffers are distributed to processing skids from a central buffer room. All consumable materials are replenished using AWS IoT buttons which allow operators to request additional inventory with a single click.

Integrated Electronic Batch Records - Testing

Integrated electronic batch records instruct operators on sampling through a real-time integration with our Laboratory Information Management System (LIMS) sample plans. Sample labels are printed and applied on the shop-floor. When samples are dropped at a pick-up location, all information required for testing is passed digitally to the LIMS system to enable QC testing. Our QC labs have an integrated data integrity solution which is implemented on workstations and captures equipment data in real-time with audit trails and security controls. When QC tests are approved, the results required for batch record calculations are passed back automatically.

Integrated Electronic Batch Records - Release

All batch record exceptions are captured digitally and can be reviewed by supervisors and the quality assurance team in real-time. Leveraging our validated electronic batch record eliminates the need to review hundreds of pages of legacy paper records. Instead, the quality team reviews and approves automated exceptions, significantly reducing cycle time.

Supply chain

Material planning is driven by our integrated clinical and operations planning (C&OP) system and processes coupled with the SAP ERP system. Structured bills of materials are used to ensure that raw materials are ordered, tested and delivered to our manufacturing suites on-time to support production. Integration with the electronic batch record system ensures inventory accuracy and allows us to utilize a pull system to inform our material planning processes.

Quality Assurance

Quality is designed into the digital strategy by ensuring data integrity, eliminating transcription errors and validating digital processes. All operational processes are supported by an integrated Quality Management System that documents deviations, change controls and required corrective actions. A paperless document management system provides controlled access standard operating procedures and compliance documentation. In order to improve efficiency and accelerate the testing of new technologies and software, validation activities are performed using an electric Validation Management System which ensures requirements traceability and enabled paperless software testing.

Personalized Cancer Vaccine

Our personalized cancer vaccine (PCV) utilizes Moderna's mRNA vaccine technology to encode a patient's specific neoantigens (unique mutations present in that specific patient's tumor), which allows us to design a vaccine for each patient. When injected into the patient, the vaccine is meant to elicit a specific immune response that will recognize and destroy the patient-specific cancer cells.

This personalized therapy adds additional complexity to the patient treatment process, compared to traditional medicine. We have addressed that complexity by fully digitizing and automating the process, including the management of the chain of custody and identity, integration with our manufacturing systems and the use of AI to design the vaccine.

The PCV Tracker app tracks and traces every step of the personalized vaccine, needle to needle. When tumor and blood samples are extracted from the patient, anonymized data are entered into the clinical CRO's system, and automatically flow to the PCV Tracker. The clinic sends the samples for next generation sequencing (NGS), which is integrated with the app. NGS data are uploaded to Moderna's secure cloud storage system, where an AI algorithm automatically runs to identify the patient-specific mutations and design a unique mRNA vaccine. The patient-specific mRNA sequence is securely transmitted to our manufacturing systems, which run the manufacturing process and store all the manufacturing data for traceability purposes. The vials are then shipped to the clinical site and

administered to the patient.

PCV is built on the same technology landscape and operational processes as our large-scale clinical operations. Data analytics enable us to learn from our higher volume, individualized batch production and apply that learning to our larger scale clinical production.

Planning our PCV supply chain also turned out to be a very difficult problem. Each patient's medicine is unique and new patients enroll unpredictably. This makes traditional supply/demand planning ineffective. To address this variability, our Monte Carlo simulation accounts for various enrollment plans, supply plans and historical process turnaround times and simulates hundreds of virtual trials. The results are viewed graphically to show how different plans impact delivery of medicine to patients on time, ultimately driving better decisions.

Centralized Data Warehousing and Analytics

Moderna's highly digital and integrated landscape gives us ample opportunity for analytics, and so we opted for a central data warehousing and analytics strategy. We synchronize data from dozens of source databases and systems into one single data warehouse using Amazon's Redshift database, a powerful, inexpensive columnar database ideally suited to analytics. This central data warehouse serves as a single source for data science and AI development, operational statistical analysis tools, and our standard business intelligence (BI) tool, Looker, chosen for its simplicity, flexibility and power.

DIGITIZATION OF THE BUSINESS FOUNDATIONS

FOR OUR FOUNDATIONAL BUSINESS SERVICES (HR, Finance, Legal, Infrastructure) we take advantage of the cloud and its multitude of software-as-a-service applications and infrastructure. This provides Moderna an optimized, simple-to-run and agile digital environment.

Our foundational business services have been built with a high level of process automation, integration and sync capabilities between the various solutions, including SAP and the applications that supplement it.

HR

Automation of HR processes is key to our capacity to scale. We have invested in Workday, a highly capable human resources software platform, and the integration and support to make it successful. Workday is the system of record for employee data, guaranteeing that the data are not replicated or touched more than once, improving data integrity and security, and limiting human errors. Employee data are entered at the early stage of the hiring process, continuously enriched and updated by the employee through a self-management portal. New hires are added to payroll with very limited effort, IT and application accounts are created, and departmental access is defined and granted. The platform is fully integrated with internal systems and external providers, including ADP for payroll processing, John Hancock for self-service 401k management, Fidelity for equity plans, and benefits and insurance providers.

Finance

To manage our financial processes effectively, to transact, and to provide analytics against the data generated, we

have implemented SAP S4 HANA as our ERP platform. This central core is tightly integrated with Workday. We also leverage external systems for expense management and automated invoicing, Host Analytics for budgeting and planning, Okta for SSO and accounts, and our own internally developed solutions. In addition to these extensive integrations, we are automating the P2P cycle with intuitive PO creation, vendor punch-outs, and mobile workflows for review and approval. Having SAP as a highly integrated system connecting finance with supply chain and manufacturing streamlines the workflows, provides real-time information for decision support, and allows enhanced tracking and forecasting, with a view to improve quality, efficiency, performance, productivity levels and scale.

Integration Platform

For a highly interconnected environment, our class-leading integration platform is Dell Boomi, moving us from simple cloud-to-cloud integrations to an evolving use of the integration platform for master data management, systems account management, and ultimately for cost savings and improved user experience. Boomi seamlessly shares data across applications, so end users can transact in the system they are familiar and comfortable with, improving user adoption and reducing training burden. Within Boomi, we utilize master data management to implement a user golden record, created as part of the hiring process within HR, and then used to provision many applications including Active Directory, SAP, Concur, Fidelity, and our internal solutions. In addition to account creation, Boomi manages account updates such as payroll changes or department changes and is central to a fully automated offboarding workflow.

Infrastructure & End User Computing

Infrastructure technology changes and becomes obsolete rapidly. The time, energy and money we spend to manage and run IT infrastructure is time not spent on growing our business. We decided from the start to build our IT infrastructure in the cloud, with a highly standardized approach. We are ruthless about standardization, as it enables our path to automation and business process integration.

The benefits of the cloud and standardization are numerous:

- lower costs, with simple provisioning and administration,
- flexibility and instant scalability in response to real-time needs,
- the latest and greatest cloud software updates, drastically improving user adoption,
- disaster recovery and high availability capabilities, where employees can access the same infrastructure anywhere
- improved information security, with high compliance to security standards
- improved collaboration with partners and colleagues

The right teamwork tools are critical. No one person or group can do it all alone. Collaboration can range from conference calls, unified communications, electronic smart boards, purpose-built collaboration tools to telepresence conferences across the globe.

- Telepresence with Cisco and WebEx Collaborative Meeting Room reduces travel and with a great interactive experience.
- Microsoft Teams allows for shared conversations and content, naturally integrated with familiar Office applications.
- Office 365 SharePoint provides collaborative tools, including online collaborative editing, and a portal for custom applications, SaaS solutions, function updates and departmental sites. It is a key repository for external partner interactions and provides security and control while avoiding email flow.

THE COMMERCIAL ENGINE - VISION

THE DIGITIZATION OF THE ENGINE to enable our commercial capabilities is at an early stage, but will establish medical affairs engagement with doctors, support our sales and marketing capabilities and deliver a world-class patient experience as they handle their illness. We are building our Commercial Engine with a view that patients will expect more than just medicines from us. Patients are more and more digitally enabled, and they will be looking for digital solutions to help them better understand and manage their situation. We expect our digital relationship with patients will improve outcomes and compliance, increase our brand strength and build a competitive moat.

In addition to a patient- and doctor-centric view, our commercial engine will strengthen our supply chain demand forecasting and our compliance. We are looking at building a robust serialization process for regulatory requirements as well as anti-counterfeiting technologies to ensure safe, efficacious therapies to patients.

PROGRESS TOWARD REALIZING OUR MISSION

WE ARE ADVANCING MEDICINES at a breadth, speed and scale uncommon in our industry for a company at our point in its lifecycle. The early productivity we have realized compares favorably to the largest biotech companies. This productivity is due both to our platform technology and the 'software-like' nature of mRNA when used as a drug, as well as to our incorporation of digital technologies. With our digital infrastructure in place, we believe are well-positioned to rapidly and seamlessly move mRNA medicines from concept through research and clinical development toward the ultimate goal of delivering for patients.

Deliver on the promise of mRNA science to create a new generation of transformative medicines for patients.