DASSAULT SYSTEMES

SUSTAINABLE MANUFACTURING
A GUIDE TO TRANSFORMATION

E-BOOK

INTRODUCTION

More than ever, consumers are holding companies accountable for the environmental impact of their offerings, and evidence shows that they're willing to pay for it.

A 2018 study by Nielsen revealed that **nearly three-quarters** of all Millennials and Gen Z would pay a premium for sustainable products and services.

These consumers are demanding sustainable product experiences; and companies need to reinvent themselves to answer these needs. **It starts with sustainable manufacturing.**

Digital technologies accelerate the development of sustainable manufacturing. It's a core component of the new 'Industry Renaissance'– the merger of automation, the Internet of Things (IoT), artificial intelligence, business processes, big data and cloud computing.

In this e-book, Dassault Systèmes invites you to:

#1 Understand

why we should care about sustainable manufacturing.

#2 Experience

how the **3D**EXPERIENCE® platform transforms manufacturing.

SUMMARY

PART 1

UNDERSTAND SUSTAINABLE MANUFACTURING

How does sustainability transform manufacturing production?

- What is sustainable manufacturing?
- Why is it a vital opportunity?
- How can companies achieve sustainable manufacturing?
- 3 success pillars
- The **3D**EXPERIENCE platform approach

PART 2

EXPERIENCE INDUSTRY TRANSFORMATION FOR A SUSTAINABLE FUTURE

How can manufacturers re-purpose old facilities, build green products and become sustainable?

- Manufacturing trends
- Sustainable facilities for greenfield and brownfield sites
- Industry response
- Products driving sustainable manufacturing
- **3D**EXPERIENCE twin
- Smart factories

PART 3

CONCLUSION

Are you ready for the future of manufacturing?

PART 1

UNDERSTAND SUSTAINABLE MANUFACTURING

PART 1.1 WHAT IS SUSTAINABLE MANUFACTURING?
A BLEND OF ECOLOGY AND ECONOMY

Why?

In the face of global warming and climate change, companies are becoming increasingly aware that they must rethink their business practices and pursue sustainable development. They understand that financial profitability must go hand-in-hand with social equity and environmental integrity.

So, what is it?

Sustainable manufacturing is the creation of manufactured products through economically sound processes that minimize negative environmental impacts while conserving energy and natural resources. It focuses on enhancing employee, community and product safety and involves different domains of action such as product, process, technology, and industry.

5 REASONS FOR ADOPTING SUSTAINABLE MANUFACTURING

1. **Increase operational efficiency by reducing costs and waste.**
2. **Reach new customers and increase competitive advantage.**
3. **Protect and strengthen brand and reputation and build public trust.**
4. **Build long-term business viability and success.**
5. **Respond to regulatory constraints and opportunities.**

THE EXPERT EYE

> **Sustainable manufacturing is not an option. It is not only about energy efficiency or zero-waste strategy. It is about innovation for social responsibility.**

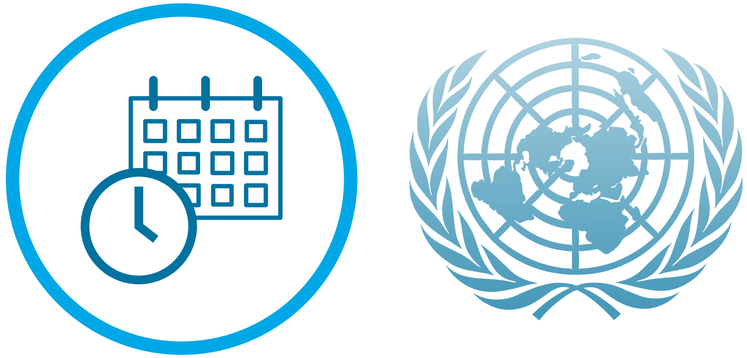
Guillaume Vendroux
Chief Executive Officer, DELMIA
Dassault Systèmes

PART 1.2

WHY IS IT A VITAL OPPORTUNITY?
MANUFACTURING IS BOTH A NECESSITY AND AN OPPORTUNITY

The world is on a fast track to consume four Earths' worth of resources by 2050.

A UN report says CO2 emissions must be cut nearly in half by 2030.



Sustainable Manufacturing can play a key role in achieving the UN's 2030 Agenda for Sustainable Development.

With the industry and manufacturing sectors accounting for 41% of global GDP, the production sectors are at the crossroads of economic impact and resource use. Companies need to find ways to remain competitive and sustainable with fewer resources.

AND THE WORLD'S BUSINESS LEADERS ARE UP FOR THE CHALLENGE

of CEOs believe that Sustainable Development Goals (SDGs) provide an opportunity to rethink approaches to sustainable value creation.

already see opportunities to contribute to the SDGs through their core business.

believe that business will be the single most important actor in delivering the SDGs.

of executives expect their products to be low carbon by 2028.

Source: YouGov poll 2018

DOING “GOOD BUSINESS” IS “GOOD FOR BUSINESS”

The green marketplace is worth trillions

SDGs could open up a market of US$12 trillion by 2030 in 4 major areas: food and agriculture, cities, energy and materials, health and well-being.

$100 trillion

According to the WEF, the value of digital transformations in the next 10 years, across all sectors, industries and geographies. The manufacturing sector is key to this transformation.

A little investment in greening may lead to big savings

The UK’s Carbon Trust estimates that most businesses can cut their energy bills by up to 20% with only a small investment - a saving that could equate to as much as a 5% increase in overall profits.

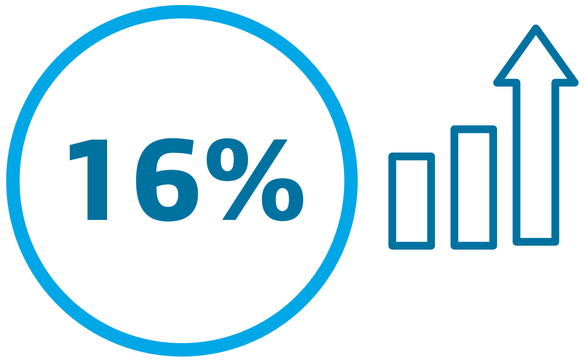
A green reputation attracts investors and employees

Consumers, employees and investors alike are increasingly embracing companies they view as:

- Innovation pacesetters with a clear vision for the future.
- Industry leaders that prioritize long-term investment strategies.
- Businesses that value corporate social responsibility.

PART 1.3

HOW CAN COMPANIES ACHIEVE SUSTAINABLE MANUFACTURING?
FOSTERING SUSTAINABILITY IS GOOD BUSINESS!



increase in market performance,
over a three year period, for companies that focus their sustainability efforts primarily on material social and environmental factors.

US$ 4,5
TRILLION

Transitioning to a Circular Economy can unlock global GDP growth of $4.5 trillion by 2030.

3 QUESTIONS BUSINESS LEADERS SHOULD ASK THEMSELVES

Question 1

How can I empower the workforce of the future?

SUGGESTION

Create a culture of sustainability awareness within your enterprise and across your value chain.

Question 2

What does it mean to be a responsible business in a digital world?

SUGGESTION

Use innovation scenario planning and strategic analysis to go beyond compliance.

Question 3

How can I increase profitability while doing more with less?

SUGGESTION

Balance increased competitiveness and potential new revenues with cost-cutting efforts for a more balanced approach.

ECOLOGICAL HANDPRINT FIRST

To reach these goals, think in terms of “ecological handprint” - the things we do that create positive changes in the environment, by reducing our own footprint and enabling others to reduce theirs. To do so, you can use the triple bottom line (3P) framework that gauges a company’s level of commitment to social responsibility and its impact on the environment.

THE 3P MEASURES:

PEOPLE

in the form of the workforce of the future, empowered to use knowledge and know-how to create sustainable experiences that inspire innovation.

PLANET

by using optimized global operations that minimize waste in crafting sustainable experiences.

PROFIT

with utilization of value network orchestration for higher efficiency, productivity and faster time to market for maximized profit.

#1 WORKFORCE OF THE FUTURE

Capturing knowledge and know-how from today's workforce empowers sustainable experiences that inspire innovation for future workers.

Key concepts

- Offer cleaner and safer jobs for workers.
- Blend human skills and digital skills.
- Collaborate with robots for better workforce and productivity, keeping humans at the center.
- Train skilled workers to program and run smart factories.
- Develop public/private partnerships and collaborations for the "greater good".

Train for the jobs of the future

- Despite common fears, new technologies are likely to create more jobs than they replace. In fact, job openings have been growing at double-digit rates since mid-2017.
- However, Deloitte and The Manufacturing Institute's skills gap study reveals a widening gap between the jobs that need to be filled and the skilled talent pool capable of filling them.
- Manufacturing leaders must embrace change and drive their workers towards a skill shift, train them for the jobs of the future and respond to the rising demand for technological, social, and higher cognitive skills.

DID YOU KNOW?

of the jobs that will exist in 2030 haven't been invented yet.

Sources: IFTF workshop, March 2017

of manufacturers say they have already adopted automation - and the top skills that must accompany technology are critical thinking, programming, and digital.

Source: Deloitte and The Manufacturing Institute, 2018

#2 GLOBAL OPERATIONS OPTIMIZATION

Optimize processes to relieve the burden of manufacturing unique customer experiences while simultaneously reducing waste in material, time, and energy.

Key concepts

• Drive circular economy and resource effectiveness; develop new materials; improve material processing systems.
• Adopt the 5R approach to achieve "zero waste to landfill:" Repair, Reuse, Refurbish, Re-manufacture, and Recycle.
• Decarbonize energy.

Some companies have already implemented sustainability policies

• China National Building Materials Group has cut energy use by 10%.
• In 2018, BMW delivered more than 140,000 electric vehicles and plug-in hybrids worldwide. By 2020, all BMW plants will be powered by green electricity.

DID YOU KNOW?

The latest Energy Transitions Commission (ETC) report "Mission Possible" has declared that reaching net zero CO2 emissions by mid-century is a very real vision!

#3 VALUE NETWORK ORCHESTRATION

Foster transparency, visibility and collaboration across the value network to bring unique sustainable experiences to market.

Key concepts

- Deliver digital innovation thanks to IIoT and smart manufacturing.
- Trust, transparency and traceability.
- Digital trust and responsibility.
- A common approach on sustainable value.

Orchestration

- Each member relies on one another to foster growth and increase value. Value network members can consist of external members (e.g., customers) or internal members (e.g. research and development teams).
- Therefore, orchestration is key to value networks, as you need to be able to coordinate industrial actors and connect them quickly and efficiently in a very agile manner.

PART 1.5 THE 3DEXPERIENCE PLATFORM APPROACH

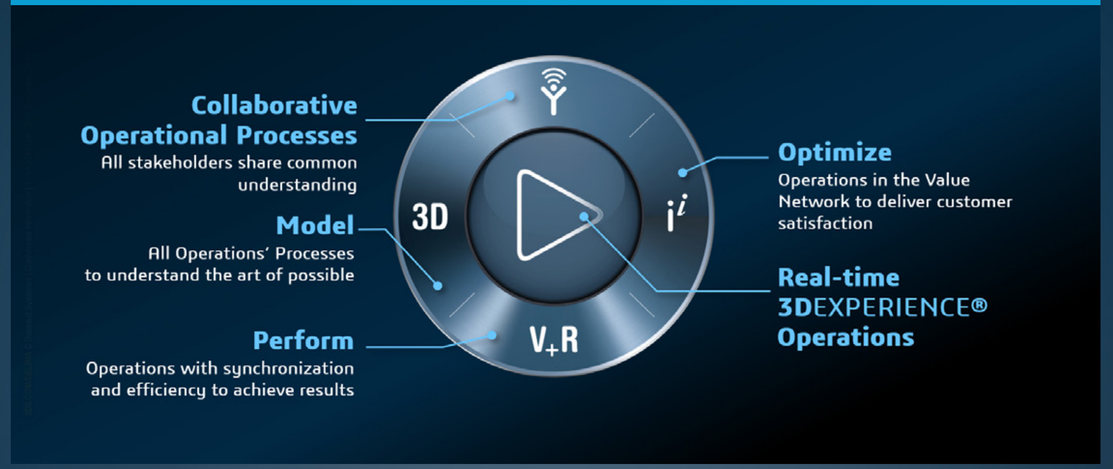
The Industry Renaissance relies on the business imperative of sustainability.

The **3D**EXPERIENCE platform provides a business and operations framework that addresses the core of what manufacturing is all about: technologies and solutions to pursue sustainable innovation and deliver results at global scale. It is the catalyst and enabler of 21st century Industry Renaissance.

A plea for sustainability

For manufacturing companies to thrive, workers must be given the opportunity to create and collaborate, to implement ideas, and make knowledgeable decisions. And for this, companies must be sustainable. It is the key concept for running business smoothly and optimizing efficiency and output for the betterment of the industry, the people and the planet.

3DEXPERIENCE® | OPERATIONS TO MANAGE THE VALUE NETWORK



AS AN OPERATIONAL SYSTEM

The **3D**EXPERIENCE platform connects processes across the lifecycle, from ideation to modeling, optimizing, simulation, manufacturing, market delivery, and usage.

AS A BUSINESS MODEL

The **3D**EXPERIENCE platform transforms relationships and roles across the value network, removing intermediaries between sellers and buyers, purchasers and subcontractors, service providers, and end customers.

PART 2

EXPERIENCE INDUSTRY TRANSFORMATION FOR A SUSTAINABLE FUTURE

PART 2.1 MANUFACTURING TRENDS

PEOPLE

The skills gap may leave an estimated **2.4 million** positions unfilled between 2018 and 2028.

Source: Deloitte, 2018

4.6 million manufacturing jobs will open up in the next decade in the US, and **2.4 million** of them will go unfilled.

Source: The Manufacturing Institute, 2018

Time spent on repetitive manual labor:
48% 2019
35% 2030

Source: WEF, 2019.

PART 2.1 MANUFACTURING TRENDS

PLANET

Current business practices will contribute to a global gap of **8 billion tons** between the supply and demand of natural resources by 2030.

66% of consumers feel it is important for brands to take a public stand on social and political issues.

Sustainable packaging can lead to a **40%** saving in energy and a **90%** reduction in water required for production.

Source: WEF, 2018.

PART 2.1 MANUFACTURING TRENDS

PROFIT

50% of all manufacturing companies will be using AI in some form by the end of 2021.

Source: IFS, 2019

US$2.9 trillion: the business value generated from AI by 2021.

Source : Gartner, 2019

The global additive manufacturing market is expected to grow to **US$36.61 billion** by 2027 from **US$8.44 billion** in 2018.

Source: Additive Manufacturing Market to 2027 Report, 2019

PART 2.2 SUSTAINABLE FACILITIES FOR GREENFIELD AND BROWNFIELD SITES

Greenfield sites

Greenfield sites are undeveloped areas within or outside a city, typically on agricultural land. They are often sought after for the construction of manufacturing plants and other commercial projects because they are uncomplicated and straightforward for construction.

ADVANTAGES

- Design flexibility to meet project requirements.
- Room to expand for future growth.
- Can be leased or owned.
- Construction timelines are typically faster.

DISADVANTAGES

- Infrastructure installation often required.
- Further away from the city and its services.
- Longer commutes for workers.
- May be viewed as urban sprawl and as a negative environmental impact.

Source: www.gray.com

PART 2.2 SUSTAINABLE FACILITIES FOR GREENFIELD AND BROWNFIELD SITES

Brownfield sites

Brownfield refers to existing manufacturing sites that are currently producing or once produced commercial products. Environmental practices of the past contributes to some being identified as contaminated, requiring environmental remediation action.

ADVANTAGES

- Reduces sprawl and destruction of greenspace.
- Contributes to redevelopment of a city section.
- Existing, usable infrastructure may already be in place.
- Improves brand image by investing in the city and being good environmental stewards.
- Grants and other incentives may help pay for clean-up and improvements.

DISADVANTAGES

- Development could be complicated by discovery of toxic contaminants.
- Generally longer construction timelines.
- Older structures may not meet structural requirements and building codes.
- Higher risk of cost overruns due to unexpected developments.
- Potential space constraints may limit expansion and slow down construction.

Source: www.gray.com

LEED CERTIFICATION

LEED certification (Leadership in Energy and Environmental Design) is a third-party certification program and a benchmark for design, construction, and operation of high-performance green buildings.

Created in 2000 by the US Green Building Council®, LEED projects are certified or under certification in more than **165 countries and territories**.

More than **200,000m2** are built LEED certified per day and **91,700 projects** use LEED certification.

CERTIFIED
40 - 49 POINTS

SILVER
50 - 59 POINTS

GOLD
60 - 79 POINTS

PLATINIUM
80+ POINTS

PART 2.3 INDUSTRY RESPONSE

Twentieth-century urbanization and deindustrialization left behind scores of empty manufacturing buildings. New start-up manufacturers coming online today are capitalizing on past industry success by re-purposing old facilities for the industry of the future.

Here is a composite look at how they are approaching this challenge.

#1 BUICK CITY IN FLINT, MICHIGAN

Background

Mahindra, maker of the Roxor off-road vehicle plans to revitalize Buick City in Flint, a property of 400 acres that had been used for automotive production since the early 20th century but was closed as part of the General Motors bankruptcy of 2009.

Sustainability key fact

Mahindra wants to build 200,000 next-generation delivery vehicles for the U.S. Postal Service, a move that could create up to 2,000 jobs over the first five years.

Source: crainsdetroit.com

#2 LATÉCOÈRE 4.0 FACTORY IN TOULOUSE, FRANCE

Background

Founded in 1917, **Latécoère** helped establish the aeronautics industry in the Toulouse region, France. Today, Latécoère is pursuing an ambitious plan that includes construction of a fully automated smart factory that operates 24/7.

Sustainability key fact

With Dassault Systèmes **3D**EXPERIENCE platform and DELMIA, Latécoère created the foundation to collaboratively model, simulate, operate, optimize and reduce environmental footprint of their future factory.

PART 2.3 INDUSTRY RESPONSE

#3 MAHLE IN XENIA, OHIO

Background

When grocery chain operator SuperValu closed a distribution center in Xenia, Ohio, in 2012, over 100 people lost their jobs. In 2015, German auto parts maker **Mahle Behr** moved in to occupy 168,000 square feet of the plant.

Sustainability key fact

The new facility is expected to add up to 45 jobs.

Source: CNN, 2016

#4 HOVIONE DRUG PLANT IN CORK, IRELAND

Background

In 2009, **Hovione**, a pharmaceutical company, acquired Pfizer's Cork plant to add a large-scale capacity from which innovative drug companies could launch products.

Sustainability key fact

"The plant is a multipurpose one that was originally designed for custom synthesis, so it doesn't have the drawbacks of a tailor-made plant," Hovione CEO Guy Villax explains. Hovione initially operated the Cork site with about one-third the workforce that could be employed at full capacity.

Source: The Verge, 2019

PART 2.4 PRODUCTS DRIVING SUSTAINABLE MANUFACTURING

AUTOMOTIVE

Autonomous driving cars have emerged as a hot buzz word in the automotive industry. **Tesla**, an EV leader, released a "Feature Complete" Full Self Driving Solution at the end of 2019. This approach to autonomous vehicles is primarily focused on computer vision, or using cameras — just like humans — to recognize and understand the world.

Source: Forbes, 2019

FARMING

EcoRobotix, a Swiss startup, launched a spraying robot for weed control in 2018. The solar-powered robot, which is due for commercial launch towards at the end of 2018, uses GPS navigation, camera-based weed recognition and two agile arms each carrying a single spray nozzle. Up to 20% less herbicide use and up to 30% lower cost are the main attraction for growers.

Source: futurefarming.com, 2018

PART 2.4 PRODUCTS DRIVING SUSTAINABLE MANUFACTURING

AEROSPATIAL

Made In Space has pioneered manufacturing capabilities in space with its first and second generation 3D printers, with on orbit operations dating back to 2014. In November 2019, Made In Space sent the first commercially developed plastic recycling facility to the International Space Station (ISS).

Source: madeinspace.us

CONNECTED HOME

Founded in 2013, **Smarter** has become one of the UK's fastest-growing connected home companies. In 2013, co-founders designed their own Wi-Fi-connected kettle. Since then, the brand has branched out by adding a fridge camera. It has been designed to save households up to £700 per year by eliminating food waste.

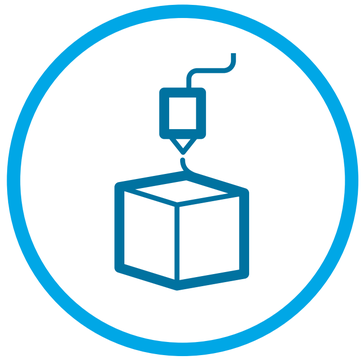
Source: Fabrik, 25 disruptive brands in 2018

PART 2.4 PRODUCTS DRIVING SUSTAINABLE MANUFACTURING

GREEN POWER

The need to change how energy is produced is driven by the demand being put on the earth's resources.
One company addressing this issue is **Vestas**. Vestas designs, manufactures, installs and services wind turbines. Wind turbines convert wind into energy. A single wind turbine produced by Vestas will generate up to 50 times more energy than it will use in its life and emits only 1% of carbon dioxide when compared to a coal power plant.

Source: vestas.com



3D PRINTING HOUSE

Apis Cor is a Russian startup that has developed a 3D printer capable of building a house in just 24 hours. The technology is capable of printing wall structures entirely on site without extra assembly required. The cost of the home's materials — including the foundation, walls, insulation, finishings, and wiring — comes to just over US$10,000.

Source: apis-cor.com

PART 2.5 3DEXPERIENCE TWIN

The 3DEXPERIENCE platform enables sustainability by allowing you to understand the impact of your ideas and processes before you commit physical resources.

The need for rapid parallel advancement in all areas of manufacturing makes **simulation** an indispensable part of the development process, accelerating creation of optimal designs.

Zero distance between virtual and real

The **3D**EXPERIENCE twin enables manufacturers to navigate the full range of solution possibilities.

DID YOU KNOW?

30% of Global 2000 companies will use virtual experience twins and IoT connected products to improve product innovation and productivity by 2020.

3DEXPERIENCE **TWIN**

Dassault Systèmes' **3D**EXPERIENCE twin guides **sustainable manufacturing**, letting companies test out different approaches in a virtual environment. That lets them see how they can best eliminate potential waste, whether in inventory, energy use, equipment efficiency or anywhere else.

The **3D**EXPERIENCE twin is **a virtual model of business processes.** It is generated from a single data model on a unified platform. A **3D**EXPERIENCE twin ensures unmatched accuracy and fidelity. When these powerful, simulated environments are used to analyze in real-time, the result is an unparalleled ability to experiment in the digital world, which in turn creates a flawless experience in the real world.

3DEXPERIENCE **twin benefits**

LOWER COSTS

FASTER DEVELOPMENT

OPTIMIZED TIME TO MARKET

INCREASED SAFETY

REDUCED FOOTPRINT

PART 2.6 DIGITAL FACTORY

WELCOME TO THE FACTORY OF THE FUTURE

The factory of the future needs an underlying digital infrastructure, made possible by the **3D**EXPERIENCE platform. Each part of the extended production chain can communicate and interact with a high degree of synchronization.

SUSTAINABILITY FROM CONCEPT TO START OF PRODUCTION

The **3D**EXPERIENCE platform creates a single source of truth for construction projects. By adopting seamless collaborative processes, multiple project stakeholders can realize significant savings in time and money and improve quality.

1 BUILDING DESIGN
Design and simulate any building, structure, building element, or object. Mockup all projects from office furniture to industrial sheds to an ultra-custom shop floor.

2 STRUCTURE DESIGN
Model, simulate, and analyze any structural element for concrete and steel frame, precast, façade, projects, and more.

3 SYSTEMS DESIGN
Plan, model, and simulate any building system element for any scale of project from single occupant to assembly plant and factory infrastructure. Design modular plants and runs to reduce field clash and shorten schedules.

SUSTAINABLE FACILITIES

4 **PERMEABLE CONCRETE**

A new type of concrete allows rainwater to pass right through it.

Sustainable benefits

- Storm water runoff in paved industrial area is a major source of water pollution.
- Permeable concrete significantly decreases run-off.
- Maintain healthy water supply.

5 **GREEN MANUFACTURING**

Manufacturers are investing alternative-energy sources, such as solar panels and wind turbines, to power their operations.

Sustainable benefits

- Renewable energy sources decrease the demand on the earth's resources.
- Reduce air pollution by not relying on fossil fuels.

6 **PLANT-BASED FOAM**

A polyurethane foam made from plant materials can be used in turbine blades, insulation and furniture.

Sustainable benefits

- Non-toxic and made from sustainable resources.
- Improve the quality of living with better insulation properties and higher thermal resistance.

SUSTAINABLE PRODUCTS

7 The **3D**EXPERIENCE twin allows product designers to quickly and easily test out different product variations, seeing how they would work in the "real world."

8 From 3D sketching, 3D printing to reverse engineering, The **3D**EXPERIENCE twin provides all the solutions for design creativity, surface excellence and product experience.

- Enable circular economy of EV Design & Manufacturing by optimizing the life cycle of EV batteries considering how to reuse, refurbish and recycle the parts and materials.

DESIGN COLLABORATION

9 The **3D**EXPERIENCE platform is highly iterative, with mechanical and electrical engineers changing things like the board outline and height of board components.

DIGITALIZED SHOP FLOOR

10 Supply chains and resources are tightly synchronized and adjusted as needed with each custom order, maintaining Lean practices in a custom production environment.

11 Robots and people are highly mobile, moving around the shop floor to implement on-the-fly changes; the shop floor itself is digital and dynamic.

12 The **3D**EXPERIENCE twin delivers the right materials to the right place at the right time, plus recording of detailed genealogy on components for traceability.

IOT + PROCESS

13 The **3D**EXPERIENCE twin allows operators to connect directly to IoT devices and to contextualize the information in a data model.

DID YOU KNOW?

- **36.13 billion**: number of IoT devices expected to be connected by 2010.
- **US$0.44**: average cost of a sensor in 2018, nearly 200% than the average cost in 2004.
- **US$15 trillion USD**: IoT's projected inpact on the global GDP by 2030.

PLAN PREVENTIVE MAINTENANCE

14 Supports operators in finding the best time to implement scheduled maintenance on a machine: before the issue occurs, and with the lowest impact on service rate.

VIRTUAL + REAL

15 Augmented Reality (AR) provides visual assistance which can simplify complex processes in assembly, maintenance and repair processes.

16 AR assists operators to address factory issues quickly and reduce machine downtime.

17 Remote assistance allows workers to have live calls with their supervisors to conduct trouble shooting and maintenance.

PART 3

CONCLUSION

PART 3 CONCLUSION

Sustainable Manufacturing must be part of a holistic approach that will transform the very heart of your operations, bringing together strategy, design and execution in a long-term perspective.

A virtual experience platform

The **3D**EXPERIENCE platform is an unprecedented opportunity for companies to embrace Sustainable Manufacturing using the virtual world to reinvent their business in a sustainable way: sustainable growth, innovation and workforce.

PART 3 CONCLUSION

IT IS A COLLECTIVE RESPONSIBILITY

Workforce of the Future

Capture knowledge and know-how from today's workforce to empower sustainable experiences that inspire innovation for future workers.

Global Operations Optimization

Optimize processes to relieve the burden in manufacturing unique customer experiences while simultaneously reducing waste in material, time, and energy.

Value Network Orchestration

Foster transparency, visibility and collaboration across the value network to bring unique sustainable experiences to market.

The 3DEXPERIENCE® Company

ARE YOU READY FOR THE FUTURE OF MANUFACTURING?

> Learn more