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THE ROAD TO SMARTER MANUFACTURING

Automation is a normal part of manufacturing and has been for a long time. Repetitive tasks are carried out by machines and the numbers of factory operatives are declining in number, but rising in skill level. They make the key decisions that control fleets of assets, driving higher levels of efficiency and quality across the production value chain.

Yet now we are creating new realities in manufacturing, as we move from Basic Automation (repetitive tasks), to Cognitive Automation, in which Artificial Intelligence (AI) informs and supports human activity, automating a large number of decisions and interventions.

Ahead of us lies the ultimate stage in manufacturing transformation: Hyper Automation, in which distributed AI creates an interdependent network for decision-making at all levels and all stages of the value chain. The role of people at these three stages moves from hands-on supervision (Basic Automation), to final decision-making (Cognitive Automation), to goal-setting and strategy, with virtually no role in moment-by-moment operations (Hyper Automation).

This is the direction of travel being taken by every forward-thinking and forward-looking manufacturer. Most of them are a long way from reaching Hyper Automation status, but that is the goal, and indeed, that must be the goal. Every factor that defines and manages the manufacturing environment makes this necessary, because the complexity of the manufacturing world, together with the markets served by manufacturers in every sector and segment, is exponentially greater than it was in the past.

THE ROAD TO SMARTER MANUFACTURING

In particular, businesses are dealing with multi-level, multi-dimensional challenges that require a larger, more strategic role for AI, including but not limited to:

- Hyper-customization.
- Dynamic adjustments to supply chains.
- 3D printing for increasingly localized, distributed manufacturing.
- Continuous optimization of environmental performance.
- Massive data flows for product optimization, product pedigree/audit and operation of autonomous products (such as self-driving vehicles).
- Security management for distributed production chains as cyber threats increase.

The strategic planning needed today should be focused on how best to chart a safe and rational, low risk course to an inevitable future, in which Industrial Internet of Things (IIoT) and AI technology will transform current thinking and behavior.

A single paper cannot cover the whole of this broad and complex argument, so NTT DATA is offering our insights and analysis of the challenges, the options and the most secure ways to begin what will be a long and complex journey.

THREE KEY TRENDS

Manufacturers are dealing with fundamental changes in every part of their operations, with a growing demand for higher product customization making traditional manufacturing processes no longer fit for purpose. In this paper we want to look at just three especially important trends, because we think these will define the next evolutionary stages for most manufacturers in most sectors.

These trends are:

1. Hyper-customization.
2. Localized manufacturing.
3. New ownership models.

Let's take a brief look at them all.

Hyper-customization

In the past, discrete manufacturers were able to build for stock, selling through local distribution networks. Levels of customization were limited and supply chains, though they have become more and more efficient, operate in much the same way they did 50 or 60 years ago. They move faster and are more globalized, which has led to greater responsiveness and reduced costs, but this can also make them vulnerable to disruption due to trade disputes (US vs China, for example) or major events such as the pandemic.

Moving to a "market of one" model cannot be achieved through traditional methods or technologies. To achieve higher levels of customization as a standard setting for most manufacturing processes requires new attitudes and substantial re-engineering of supply chains and factory processes. Yet the expectations of customers, from consumers through to large enterprises, have now been set. They expect to receive the exact product they require and see customization as a necessary- and normal- fact of life. Whatever the difficulties, manufacturers have little choice but to move fast in this direction.

Localized manufacturing

In recent decades China has become the de facto “workshop of the world” but there are growing doubts about the future of this “outsourced overseas” model. As we move to develop distributed manufacturing techniques, using potentially disruptive methods (3D printing, for example), so the current approach is no longer seen as best practice for the long term.

Future changes will go beyond simply choosing different locations for “outsourced” manufacturing models. We can see a future in which the huge, centralized manufacturing plant of industrial orthodoxy becomes another part of history. By building smaller satellite plants for supply of customized products to local markets, we transform supply chains, reduce environmental burdens, simplify logistics requirements and bring greater agility into our processes. This is likely to be the winning future model.

New ownership models

Disruption is also likely to impact on ownership in many different segments of the market. In particular, the growth of “servitization” is impacting current business models. This approach involves challenging classic ownership models by:

- Moving to packaged solutions, such as payment by outcomes and results, rather than by basic product ownership;
- Reducing levels of financial and operational risk (move to OpEx, lease rather than buy…); and…
- Monetizing the growing importance of the services and data that surround a product, as well as the product itself.

New technologies, combined with the current infrastructure for connectivity and data analysis, empower the creation of new models, support the concept of greater customization (delivering a precisely crafted solution) and permit the entry of new businesses with different views on key markets. Automotive is a likely early mover in this regard, due to a combination of factors (move to autonomous vehicles, making data more important than standard engineering, together with the ambitions of Tech companies) but others will follow.

TEN KEY CHALLENGES

As manufacturers plan their move to a very different future, they are likely to face most or all of the following challenges. They come with varying levels of urgency: some will be well understood, while others may be more difficult to deal with.

1. Upgrading legacy technology and systems

We all recognize that what we are able to do is constrained by what our current systems will permit. All manufacturing businesses include a high level of capital investment in the form of equipment and IT systems that are rigid, often obsolescent but that cannot simply be replaced at once.
Stage-by-stage, non-disruptive replacement is the key to cost-effective transformation. This is a major organizational challenge.

2. Connecting operational siloes

Manufacturing centers can be a bit like archaeological sites: they reflect the organization and operating norms in place when the site went live- potentially many years ago. Industry 4.0 requires integration at a very deep level, enabling end-to-end manufacture as far as possible. Siloes prevent this vision from becoming reality, and siloes exist at every level- in physical layout of machines, warehousing and storage, distribution and supply chain, IT and, most critically, within organizational management. You need a plan for carefully removing these siloes, while ensuring that no process is disrupted as a result of change.

3. Closing the IT-OT divide

Integration of necessity requires the formal elimination of the long-term divide that existed (or still exists) between operational technology (OT) and information technology (IT). Up to the fairly recent past, it was widely assumed that IT and OT would remain separate disciplines and would not communicate at an operational level. In other words, you could not drive business systems through automated output from manufacturing systems, and you could not drive manufacturing equipment out of business systems. This divide is being removed as part of the digitization and data revolution. Managing this is very complex and can lead to serious issues, not least in:

4. Stronger focus on Cybersecurity

There was a time when security in manufacturing meant having a high fence around your factory. As we integrate all systems more closely, however, and maximize the potential of rich data flows to optimize all aspects of the business, so security issues become more urgent. Any system connected to the internet is potentially hackable, and all business systems, by their nature, will eventually have some connection or other to the internet. Engineering businesses are rightly very security conscious, and this explains why they have been slow in some cases to adopt data-driven process changes. To compete in a connected world, however, this barrier to adoption must be overcome, which means a step-change in how security is managed.

5. Integrating and upgrading control systems

The drive for straight through, end-to-end processes in manufacturing lead inevitably to the need to manage fleets of production assets from central control locations. The number of hands and even eyes on the factory floor is being reduced as a matter of course, so smart, large-automated management systems, integrated across all machines and processes, are becoming more important to future factory design. These management systems, in turn, depend on:

6. Enabling higher levels of automation

The last major breakthroughs in discrete manufacturing were driven by the rise of automated production machines, which improved quality, efficiency and speed to market. On their own, however, such machines do not constitute a true revolution. Automation needs to cross production siloes, aided by the “single pane of glass” approach to system visibility, and all of this depends on:

7. Making use of richer data flows

All production machines create vast amounts of data, as a matter of course, and the levels of data production are rising exponentially due to the proliferation of sensors and move for primary storage to the near-limitless capacity of the cloud. Data is the key to predictive maintenance (extending the life of assets, improving their operational efficiency and productivity…), and to managing output more effectively (providing a “pedigree” for each and every product and component, as proof of value to customers, while enabling micro-management of all process stages). Data is also key to the long-desired move to:

8. Closer connection between production and market demand

This gives senior management a clear view of market requirements, deep understanding of trends, early view of decision parameters, leading to greater market agility and a better way to build much more customized products. Data analytics extends far beyond production issues, therefore, enabling better “packaging” into complete solutions and unlocking new markets for product-related services. Integration of data flows from production and market also enables:

9. Supply chain optimization

Bringing higher levels of agility into what are increasingly complex systems, as we all aim to deliver precisely what customers demand, exactly where and when they need them. In some cases, this may lead to a move from very large, centralized plants, building massive numbers of similar products for store and later sale, to smaller, more local plants, making small production runs of many, many more variants. In other cases it may involve moving the location of sub-assembly production for delivery to the plant, to take account of changing rules in different jurisdictions and to enable faster, more varied component use.

10. More agile management of factory sites

Finally, we need to remember that even very different, more streamlined production sites will involve constant physical movement of materials, components and products in different stages of completion through, across, into and out off the main production space. The growing use of automated handling and autonomous vehicles for these requirements will, themselves, need to be managed through specialized systems that will integrate smoothly and logically with the main business and production processes.

This list is not exhaustive, but we think that all manufacturers making the transition to an Industry 4.0 model will need to address all these issues. Different enterprises will be at different stages of maturity and development, so their priorities will vary. These challenges, however, are unavoidable and the way they are managed will determine how fast and successful you are in moving to where you want- and need- to be.

Finally, we need to be clear that creating a truly integrated strategic approach to the entire process of change remains a serious issue for most enterprises, not least because their own internal organizational structures make this difficult. We have no doubt, therefore, that managing change effectively will stretch not only the technology and engineering skills of even the largest and most advanced company, but also their management and cultural abilities.

PLANNING YOUR JOURNEY

We believe that all manufacturers need to achieve greater levels of agility and flexibility in what will be an increasingly unpredictable and volatile business environment. This simple vision establishes a direction of travel- but the starting point will be different for each individual organization.

Enterprises will already have undertaken many actions and be at varying stages of development. You will always need to begin from your current position- whatever that may be- and move at your own speed. You will need to be clear about your own levels of maturity to build an appropriate and achievable strategy. This should have well-defined goals and be capable of measuring progress at every stage of development.

We believe the most important individual requirement today is for Digital Transformation, which normally involves three stages:

Data Digitization

This covers adoption of digital technologies to drive automation, consistency and the ability to manage through predictive intervention. In practice, most manufacturers have already made significant progress in this area through investment in automated machines, sensors, edge devices, integrated control systems and cybersecurity solutions. They are likely to be at different levels of assurance and maturity here but most will be using adoption of data-driven solutions to transform performance of their individual plants.

Business Digitization

This is a major step forward from initial investments in automation and controls. By integrating across OT and IT, enabling production and business systems to interact, and by implementing advanced data analytics, enterprises can unlock potential new revenue streams, target market segments (often micro-segments) more accurately and improve processes, thereby transforming operational efficiency and cost performance.

The step-change here is the move from benchmarking and measuring against historical data to use of real-time data flows to optimize performance dynamically across multiple parameters. This is the key to developing new business models and enhancing the profit potential of the business.

Digital Transformation

This will move the enterprise from being a series of separate sites and processes to being a living, integrated unit that grows and develops as a whole, in a more organic way. For example, earlier stages may very well be confined to individual sites, without necessarily impacting on the whole business.

Transformation, by definition, is about the entire organization in its global business context. It connects and integrates all relevant systems and ensures openness to signals coming from the market and trends as they emerge, trends that can be technical, social, logistical, even political in their nature. This is not a process that can happen in an isolated way: it is a comprehensive activity that requires strong leadership, commitment to and understanding of the changes in progress, and a clear vision of the future.

Finally, digital transformation is an enabler for a visionary and potentially successful business strategy. It is not to be mistaken for the strategy, itself. The digital roadmap provides a blueprint for an enterprise that is already building successfully for the future, is confident about its future development and is undertaking a range of activities in redefining business culture and organizational structure.

It is designed to provide the foundations, the ability to move data in sufficient volumes and the integration points for established systems, and for the innovations that will be appearing in the next few years.

ENABLING CHANGE BY ORGANIZATIONAL TRANSFORMATION

Before we look at the ways in which technology will drive effective change, let us also remember that integration of different disciplines and areas of expertise is the essential starting point. Technology, vital though it is, will never be more than an enabler of change. Attitudes and organization come first. Here are some examples of what we mean.

Becoming more customer-centric

This is the necessary first step towards developing a practically achievable “market of one” strategy. It is an easy ambition to have but a hard one to turn into reality. Every step along the customer-facing value chain is traditionally managed as a silo, so to provide a more responsive, agile and flexible approach to dealing with customers means integrating across all of these very different silos.

Sales and Marketing need to be intimately linked with Research and Development, for example, and also integrated with after sales, maintenance and other forms of customer support. All aspects of product financing must be integrated, and the entire supply chain has to be treated as a single entity, with end-to-end visibility so that the entire customer experience can be managed with real sensitivity and responsiveness.

Ecosystem working

To take the next steps towards building precise solutions for specific orders, and to do this at an acceptable cost, requires major changes in supply chain management, automated manufacturing and in providing solutions that go beyond the core product. In the future, we can expect to see growing use of collaborative design between manufacturer and customer, enabling unique features to be embedded in all products sold.

Supply chains will increasingly be managed through predictive algorithms, with manufacture carried out on a configure and engineer to order basis. This will require an ecosystem with all stakeholders involved in the supply chain, and with all stakeholders seeing the ultimate end user customer as their customer too. Some key aspects of what seems to be a revolutionary approach are actually in place today, but much higher levels of coordination are needed within systems of record to deliver the required step change in performance.

Building smarter products

Digitization not only permits smarter manufacturing and value chain management, it also makes it easier- and more natural- to provide products that have intelligence built into their core design. Data is a value-add to each item manufactured and sold, as all the data collected in production and implementation lead to better understanding of real performance parameters. This process is being enabled by the rise of sensor-based technology, the growth in IIoT use and the gradual development of viable AI options for improved management.

There are inhibiting factors, not least fears about privacy, data misuse and potential cybersecurity breaches. Despite these issues, we expect some sectors (automotive, consumer technology, household products, smart city and healthcare equipment) to reach the point where intelligence, together with the ability to carry out limited actions autonomously, will be completely normal in the next few years.

Manufacturers will become more ambitious in designing solutions that embrace digital capabilities in order to satisfy this growing demand for access to smart technologies. Every part of their own value chains will therefore need to change in order to embrace new disciplines and capabilities. New research partnerships will become necessary and new ways to manage customer relationships. Once again, the core systems that integrate all aspects of design, manufacture and sale will be challenged to develop in new ways to meet this challenge.

Creating a digitally-enabled supply chain

Manufacturers in most sectors are coming to understand the need to make their factories smarter, and investment in automated machines, backed by growing use of data analytics, is helping to transform performance in this regard.

Digital supply chains represent a more complex challenge, however, as this involves not only activities under their own direct control but joint working with suppliers in a more agile way than before. To build trust and improve joint working, techniques devised for quite different purposes, such as Blockchain, are successfully being used to build confidence and ensure fairness to all participants.

We can expect to see growing use of predictive management models, enabled by real time data flows, and use of modelling to provide more granular management at all stages in the value chain. Digital twins will become more important in this model, not just to provide better understanding of how products work but to model the entire manufacturing capability engaged in production. Fine-tuning how the supply chain works will move from a weekly, monthly or even annual activity to becoming a moment-by-moment practice, informed by data and enabled by AI.

Establishing servitization and outcomes-based business models

Perhaps the most noticeable change for many or even most manufacturers will be the move to outcomes-based models, which is also known as servitization. In many sectors, manufacturers are resisting this change, but it is becoming inevitable, as customers require the flexibility that comes from knowing they can pay for outcomes, enabling more agile strategy development and also greatly reducing their own financial risk.

This is precisely why manufacturers in some cases do not like this change, because they see it as transferring risk form the customer to themselves, moving from a simple business model (I make a product, you pay for it…) to a different form of relationship (our value proposition is now tied up in your success, so we are engaged continuously). In fact, major benefits are available to manufacturers that embrace this change, especially when it becomes clear that the service elements of a sale lead to higher margins and greater profitability.

Nevertheless, it is true that the value chain must now evolve, new partnerships developed, a requirement for long-term financial input from an external banking partner is likely to be necessary and new risk elements are included. The pressure on core systems to manage more granular data flows and provide higher quality predictive insights becomes a matter of basic necessity.

ENABLING CHANGE BY TECHNOLOGY TRANSFORMATION

Moving towards the goal of Hyper Automation requires mobilization and integration of different technologies to build a core platform that provides a dynamic, scalable, continuously evolving environment for joint innovation, development and production.

Let’s remind ourselves of some reasons why this is such an urgent and important requirement by looking at one example of the market-driven changes that make new forms of collaborative technology platform essential.

In the automotive market, we are seeing:

- 20% reduction in the model cycle, meaning that entirely new models will be brought to market every 3 to 4 years, as a basic requirement for remaining competitive.
- Growing divide between standard models (for shared ownership market) and precisely customized products (for individuals).
- Need to support a growing range of powertrain options, without major price penalties.

Other industries, such as pharmaceuticals, present equal or greater requirements for shared innovation, integration of new capabilities (especially those based on IIoT and massive data flows), leading to re-engineering of value chains end to end.

Our view on investment priorities at this stage remains based on the following principles:

1. This is a step-by-step process, with risk minimization and management at its heart.
2. There is no single right or wrong answer and it is a given that companies will necessarily start in different places- the direction is what matters.
3. Collaboration and transparency are essential, within a highly secure environment.
4. Data-driven integration across the value chain is the single most important enabler for competitive advantage in this changing world.

Connected value chain

Although it is always a pleasure to focus on innovation and blue sky thinking, the key to competitive advantage in manufacturing lies in the core platforms. These are the components that we think of as the manufacturing value chain: there are 5 of them. The more closely they are integrated and are able to support and enhance or optimize each other, the faster a manufacturer will move towards Industry 4.0-type production excellence and the more competitive they will be.

Complexity is caused by the fact that, in a collaborative ecosystem, the task ahead is more demanding than breaking down internal silos (important though this is). It is about embracing flexible, sometimes constantly changing or developing groups of co-innovators and stakeholders within the same environment working to the same principles. The value chain components are:

- ***Fulfilment.*** Ensuring that the right flows of quality components, parts, raw materials are always available as needed. This means correct prediction, strong ePedigree systems to manage quality, and a well-managed supply chain. This is how to ensure that you optimize stock and throughput of goods to meet fluctuating and constantly evolving demand in a dynamic environment in which every aspect of design, down to the fundamentals, is evolving fast and often unpredictably.

- ***Production planning.*** This has become a completely different discipline in a world of automated systems, driven by rich data flows, with a strong market of one focus. It is not longer possible to build large runs of identical products for stock, but instead it is necessary to build very small runs (sometimes and individual product), focused on precise needs, definite orders, yet without making each product a "special" (higher cost and lead time). The agility needed in marrying data to automated machine operation is extremely granular and needs to be managed with high levels of precision.

- ***Production execution.*** As we target a world of Hyper Automation, we have to accept that almost every aspect of production is subject to major changes. Instead of individual, specialized machines, each carrying out its own specific task, we are building integrated ecosystems of intelligent platforms.

  These are capable of very rapid configuration, driven by and responsive to data, and often built in the form of satellite plants for local production, increasingly incorporating such new technologies as 3D printing. Systems need to progressively reduce energy and resource utilization, while cutting waste and delivering to order with great precision.

- ***Quality management.*** This has not been a reactive discipline for decades now. Quality is increasingly engineered into projects from the outset, but the arrival of data analytics adds a new depth to quality through predictive intervention to avoid issues arising in the first place. Each product, however low cost it may be, can be provided with its own auditable data pedigree, so that all relevant details are known in real time as production takes place and during sale and after-sale.

- ***Plant optimization.*** The moment-by-moment operational status of production equipment is now monitored and analyzed as a matter of course. Specialized software products, such as PLM and APM enable predictive intervention, not just to avoid downtime but to ensure that all indicators (from efficiency to environmental performance) are optimized. A combination of cloud-based management systems and low latency edge devices enable instant intervention as needed (for alerts) with expert management from centrally located teams.

All of these elements need to be enhanced and on a constantly developing path to excellence, but they also need to be as near perfectly integrated as possible, internally within the company and externally with the whole network of your connected supply chain.

That is a major challenge- but it is a challenge that can be successfully addressed by reviewing the usage of your SCM, ERP, MES and PLM systems. Modernizing your digital SCM/ERP core to enable agile digital processes, making use of latest available technologies like SAP S/4HANA, and efficiently connecting those to your MES/PLM systems can give you an edge on the competition.

End-to-end data flow

It is clear to the entire manufacturing sector that data is now the key to long-term competitive advantage. It might be said that data management is the key to survival, in fact. In developing the required rich data flows, we think 4 key components will prove to be priority areas for investment and development.

- ***Predictive analytics.*** Deriving real-time or near real-time actionable insights from the data produced within the value chain. This is key management information and feeds into all aspects of set up, maintenance and optimization.
- ***Augmented reality/virtual reality.*** Adding value to management of production assets by enabling skilled operators to carry out faster diagnostics, more effective control of tasks, while enabling experts at remote locations to “be on the spot” for hands-on support.
- ***Digital twins.*** Increasingly vital for testing scenarios and evaluating how different production options will work in reality, while profiting from the speed and risk-reduction that only virtual systems can deliver.
- ***AI.*** The key to breaking from traditional development and production methods to a future of more autonomous operations, supported by machine intelligence and multi-agent systems, bringing human disintermediation, driving unprecedented levels of operational efficiency.

Integration across the value chain is not achievable without establishing and managing this level of end to end data flow, which has as its goal the normalization of AI as a fundamental component in advanced manufacturing systems.

Establish your position in the path to autonomy

All manufacturing companies that expect to survive and prosper in the next decade, will be on a journey from today's reality, where most of them are building (or in some rare cases, have already built) effective industrial data platforms, to the desired future state, in which intelligent agents enable hyper-automated operations.

To make this step-change in performance, NTT DATA has set out a "ladder" of development, with specific capability modules for each step along the way. These enable what would otherwise be an arduous journey to be broken into discrete steps, which can be ringfenced, with risk and investment capped, and each development fully proven before moving on.

As we will see in the final section of this paper, a pragmatic approach is essential for making progress. The operational landscape is complex, the marketplace unpredictable and the potential risk and cost of poor decisions is unacceptable.

PARTNERING AS THE KEY TO SUCCESS

It is easy to generate excitement about the prospects for rapid transit to the world of Hyper Automation, but actually getting there is a risky and complex business. We are seeing some large OEMs investing a high proportion of their total incomes on Smart Factory concepts, with the automotive industry (to give one example) investing an average of 2.2% of gross revenue, which may rise to more like 3.5% over the next two to three years.

That means many tens of billions of dollars in capital will be tied up in projects that have no clear end date and with ROI that is far from clear. Consultancy figures propose savings of up to 160 billion USD per annum for the automotive industry alone, if they could only monetize the full potential of smart factories, and this concept, which is disputed, may be different depending on who describes it, and is by no means full Hyper Automation, is very far from being realized.

Recent research by McKinsey revealed that around 70% of all companies engaged in developing smart factory concepts were trapped in successive pilot projects, leading to reworking and further testing- seemingly endlessly. The phrase used by McKinsey to describe this is Pilot Purgatory.

NTT DATA, as a business that understands value chains, connectivity and major production systems from the inside, takes a realistic view of the business imperatives and the processes involved. Our proposed path to the future is therefore practical, and requires auditable information for review at every stage. Key principles for transformation include:

Focus on Business Value

Each stage of development needs to show positive outcomes before moving on. We know from experience that measurable benefits can be- and must be- captured to justify investment in all subsequent stages, and we will ensure this happens.

Transform through integration

The manufacturing landscape is more complex than ever. We are seeing radical disaggregation across value chains, and that drives the need for successful integration at the systems, management and software level. NTT DATA proposes creation of a Smart Operations Framework to ensure that your own personnel can exercise full control over the environment. This framework can be adapted for flexible use from largely standardized components, leading to rapid roll-out and fast benefits realization.

Create capabilities for deployment

This is about paying attention to the core of every manufacturing business. For at least half the world's leading manufacturing enterprises, that makes SAP the natural starting point. We have moved away from the original concept of ERP as a system for managing resources within fixed production environments to a more broad and ambitious present-day reality, in which specialized software for MES, APM, R&D, finance and maintenance now interface successfully with core SAP planning and backend systems.

Scale deployment capabilities and technology

Use of digital twins, DevOps, rapid prototyping and testing will enable faster creation of potentially successful concepts. Scaling for roll-out will remain a huge challenge, however, and risk management will be directly linked to the robustness of the development environments in use. Connecting agile DevOps techniques to an SAP S/4HANA backend enables a direct link between concept and practical implementation. This, in turn, enables better risk reduction and fast benefits capture.

Manage impact capture

This is the last but, in some ways, most important component of this pragmatic go to market approach. Benefits will be identified at all stages and in every scale (from the very small to the game-changing). We insist on “banking” these benefits at once and in full. This is the key to long-term success: ensuring that every new stage of development starts from a more advanced and solid position of success.

Connecting this very much “new world” control approach to the constantly evolving core systems that remain at the heart of the enterprise enables manufacturers to maximize their own existing capital investments, ensuring these deliver a strong return into the future, while delivering the operational agility that a new kind of marketplace requires.

This combination of innovation and practicality is the hallmark of the NTT DATA approach to manufacturing core systems development. It defines a low risk, cost efficient strategy for optimizing competitive position and delivering long-term success.

Choosing a partner

NTT DATA is not simply an IT services business, and we feel this is very important for making the step to a fully-realized digital enterprise. As one of the world's largest industrial organizations, NTT DATA has been at the heart of all previous transformation waves in key industries worldwide.

For us, there has never been a real divide between IT and OT because, as **leader in telecommunications**, manufacturing insider (with business units based on decades of close partnership with industry giants like car OEMs), we have always needed to integrate production and business systems- it is part of who we are.

We recognize that communication is at the heart of the digital transformation roadmap. Data is changing everything, but only if your infrastructure is able to hold, switch, transfer and analyze data at volumes that are unprecedented for most enterprises. Communication, on a huge scale, worldwide, is a core business for us. There can be few, if any, companies in the world that understand the detailed requirements for managing data in the way that we do, being part of the world's 3rd largest connectivity company, Japan's national telecom provider, NTT, all aspects of connectivity, mobility and communication are part of our core skill set.

NTT DATA is an SAP champion, and one of the Top 10 worldwide SAP specialist partners, according to Gartner. Our global manufacturing practice combines all these specialist capabilities in one global team, skilled at addressing the key challenges facing the industry today and tomorrow from the most strategic position: leadership in core industry systems.

In a connected world **security is a non-negotiable basic requirement**. Manufacturers have rightly been highly conservative about data sharing in the past, for reasons that range from protection of IP to avoiding production errors or malicious interference. In the future, however, interconnected, extended and complex ecosystems will be a normal fact of life. Manufacturers will need to apply the same rules to their own operations as required from Critical National Infrastructure (CNI). **NTT DATA is already a CNI provider** in many different jurisdictions. We know exactly what is involved in keeping your own and your customers' interests secure and we will provide this inside knowledge to our partners.

The future will belong to the most successful Innovators, and NTT DATA is already one of the **strongest players in global R&D**. We invest close to $3.6 billion every year on original research and we have also been a research partner to some of the world's most successful manufacturers, with deep roots in all aspects of advanced communication, automotive and other key sectors.

Every company recognizes the importance of innovation, but only a few of them actually have the scale, connections and ambition to be leading innovators in their own right. NTT DATA is one of that elite group, and that makes us natural partners for the most ambitious and forward looking of manufacturing enterprises.

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Global Industry Head SAP Manufacturing

RYO YOSHIDA
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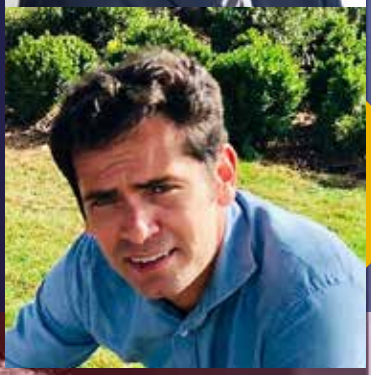

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