MURANO CORPORATION

A Value Chain Integration Company

Industry 4.0:

Six Principles, Implementation, and the Supply Chain Impact

EXECUTIVE SUMMARY

First came steam power, then mass production, then industrial automation. We are now at the dawn of the next wave: Industry 4.0, which combines Cloud Computing, Big Data and Analytics, Horizontal and Vertical System Integration, the Internet of Things, and Cybersecurity to interconnect manufacturers and their customers and suppliers in an extended supply chain. It introduces the much-awaited convergence of digital and physical components in the manufacturing world. Industry 4.0 factories will be embedded within the global networks of supply and demand through Cloud Computing. Geographical boundaries will be erased as superior technologies provide instant communication between machines and users around the world. Smart factories are approaching zero downtime, supply chains are becoming transparent, and mass customization is becoming the norm. More and more American manufacturers are leading the wave in adopting new and revolutionary technologies that provide a devastating blow to their international. Can you afford to wait?

HISTORY

The term Industry 4.0 was coined in 2011 at the Hanover Fair, the world's largest industrial expo. It is used to describe networked value chains that can self-regulate, meaning that manufacturing lines can automatically trigger critical maintenance procedures or reconfigure production to accommodate sudden logistical problems. Networks continue to grow in complexity as value chains expand globally, and the monitoring and control systems that once oversaw a single facility are now being linked across multiple locations. Companies that wish to compete effectively in the twenty-first century must act holistically across every department at every location, including suppliers and end users.

SIX PRINCIPLES OF INDUSTRY 4.0

Interoperability	Virtualization	Decentralization	Real-Time Capability	Service Orientation	Modularity
Interoperability is the ability of all components of a company – human and mechanical – to communicate with each other. This peer-to-peer communication allows information to be rapidly disseminated throughout the value chain, increasing response agility.	Virtualization is the use of sensor data to create virtual models for predictive analysis and simulation. Value chains and manufacturing lines can be reconfigured through computer models to predict production impact before its real-world undertaking.	Decentralization means giving individual components the ability to adjust to current conditions autonomously. This can be as simple as opening inventory counts to suppliers to allow "just in time" restocking, or as complex as reallocating production resources among several different facilities to accommodate a special order.	Real-Time Capability involves the immediate collection and analysis of critical data (e.g. manufacturing output, balance sheet, customer requirements, market changes, etc.). Industry 4.0 systems give workers and management the means to make decisions based on an up-to-the-minute status of any aspect of the company's operations.	Having a service orientation allows for more adaptive production capacity. Mass customization is achieved by intelligently allocating resources where they are most needed in a timely, efficient manner.	Modularity involves the ability to swap individual production modules in and out as required, whether to accommodate required maintenance, fluctuations within the value chain, or special requests from customers. Through interoperability, modules in different locations may be tasked to achieve a single goal.

IMPLEMENTING INDUSTRY 4.0

Many components of Industry 4.0 systems are already in use in small, isolated applications. Successful implementation requires that these optimized cells be expanded and fully integrated throughout the chain, both horizontally and vertically. Areas of focus can be largely divided into two categories: the Internet of Services and the Internet of Things.

THE INTERNET OF SERVICES

The Internet of Services is the label applied to a configurable pool of networking resources that can be allocated on an on-demand basis. Resources may include processing power, storage space, access to applications or data, and more. The most common application of the Internet of Services is Cloud Computing, which allows companies to erase the boundaries between physical locations, and provides a common platform for all departments. The Internet of Services is the backbone of all six principles of Industry 4.0.

THE INTERNET OF THINGS (IoT)

The Internet of Things refers to smart machinery. It is any instance in which a physical object has connectivity to a network, such as 3D printers, scanners tied to an inventory system, robotic assemblers, etc. Connecting these machines through a network allows companies to more precisely allocate physical resources such as raw materials, track maintenance and efficiency benchmarks, remotely control production lines, and more.

When these two Internets are completely integrated, companies have more flexibility in choosing locations, suppliers, and distribution channels. Plant layouts become more flexible as the production chain becomes more transparent to suppliers, designers, and end users. Downtime is reduced as the system self-regulates in response to changing production demands and maintenance schedules. Production feedback is combined with market data to provide essential analysis.

ISA-95: AUTOMATING MANUFACTURING ORGANIZATIONS AND THEIR FACTORY FLOOR CONTROL SYSTEMS

ISA-95 is an international standard from the International Society of Automation for automating a manufacturing organization and its factory floor control systems. Importantly, it has been and adopted by Industry 4.0. It is used to exchange information to accomplish manufacturing operations management between sales, finance, logistics, production, maintenance and quality (as in Figure 1). ISA-95 specification facilitates real-time access to critical data by establishing a bridge between Business Planning & Logistics and Manufacturing Operations Management systems. It incorporates the Business to Manufacturing Markup Language (B2MML) XML standard.

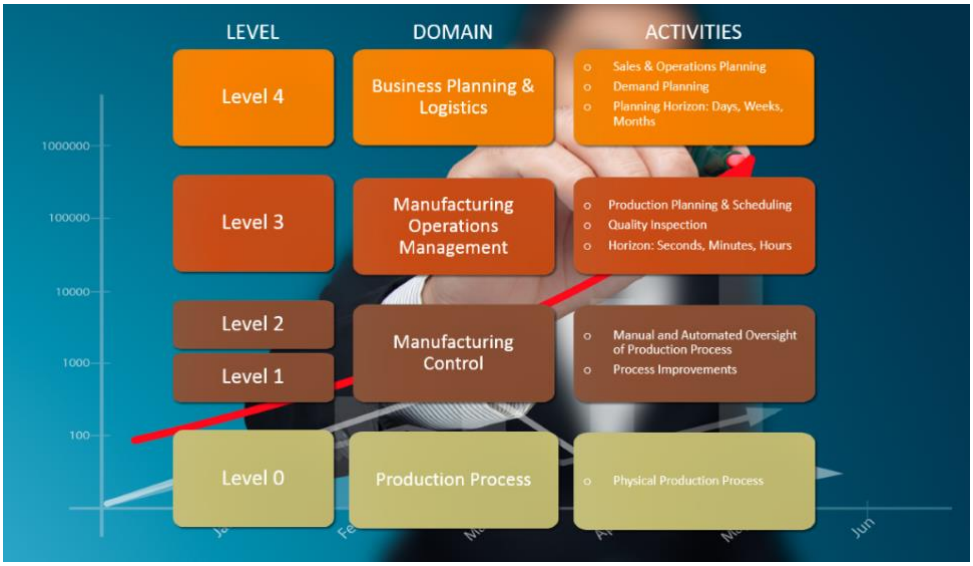


Figure 1: ISA-95 Manufacturing Levels, Domains, and Activities

OPEN PLATFORM COMMUNICATION UNIFIED ARCHITECTURE (OPC UA)

OPC UA is an open architecture using Internet Protocol (IP) to exchange information throughout an automation system with Web Services, a computing industry standard. It can reside at all levels of a system, including embedded controllers, and completes the vision of Internet Protocol to the Internet of Things.

PLCOPEN

PLCopen enables the exchange of information between controllers, systems, enterprise and the cloud. PLCopen OPC UA is a collection of universal, secure, and reliable network communication methods built on industry standards.

BROAD IMPACTS

As more and more companies around the world adopt the principles of Industry 4.0, its broader benefits are already being discovered. Industry 4.0 is transforming manufacturing relationships from silos to an integrated information and product flow that goes across borders. Integrated communication throughout a value chain optimizes work-in-progress inventory. The complete vertical and horizontal integration of networked systems gives manufacturers greater factory flexibility, and allows them to accommodate more special requests from more customers. Things like small-batch product runs, or linking to new, remote production facilities to take advantage of cheaper labor, more abundant raw materials, or reduced delivery lead times is more and more feasible. This expanded integration has created higher revenues and increased productivity on a company level, as well as leading to general industry-level improvements such as higher employment and more investor capital. In addition, related knowledge-worker industries such as software development, architecture, and network engineering are also seeing growth.

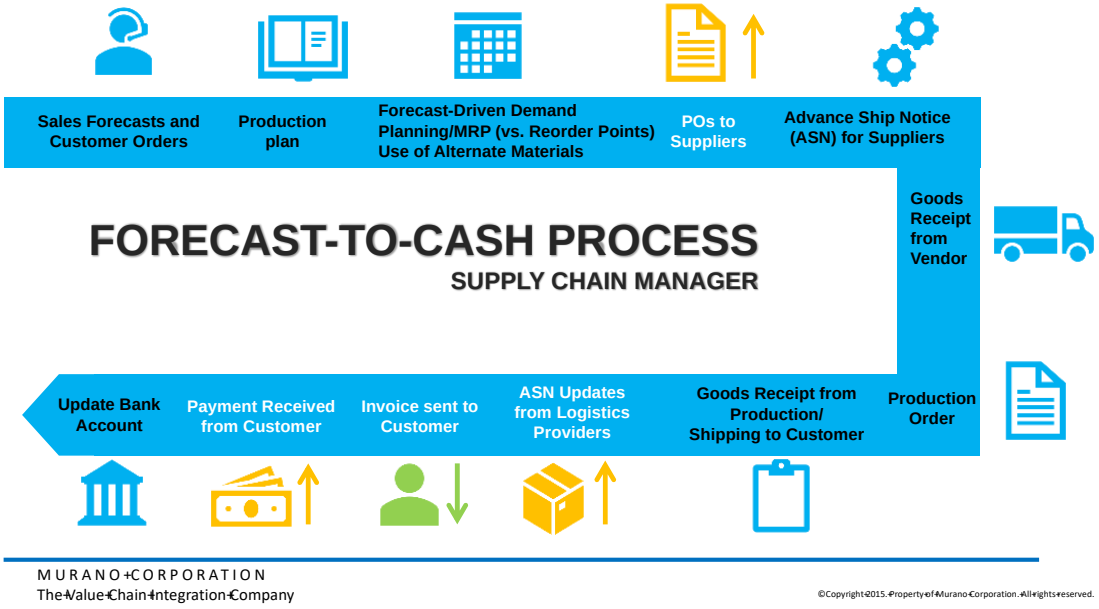


Figure 2: Industry 4.0 is transforming manufacturing from silos to an integrated information and product flows across borders

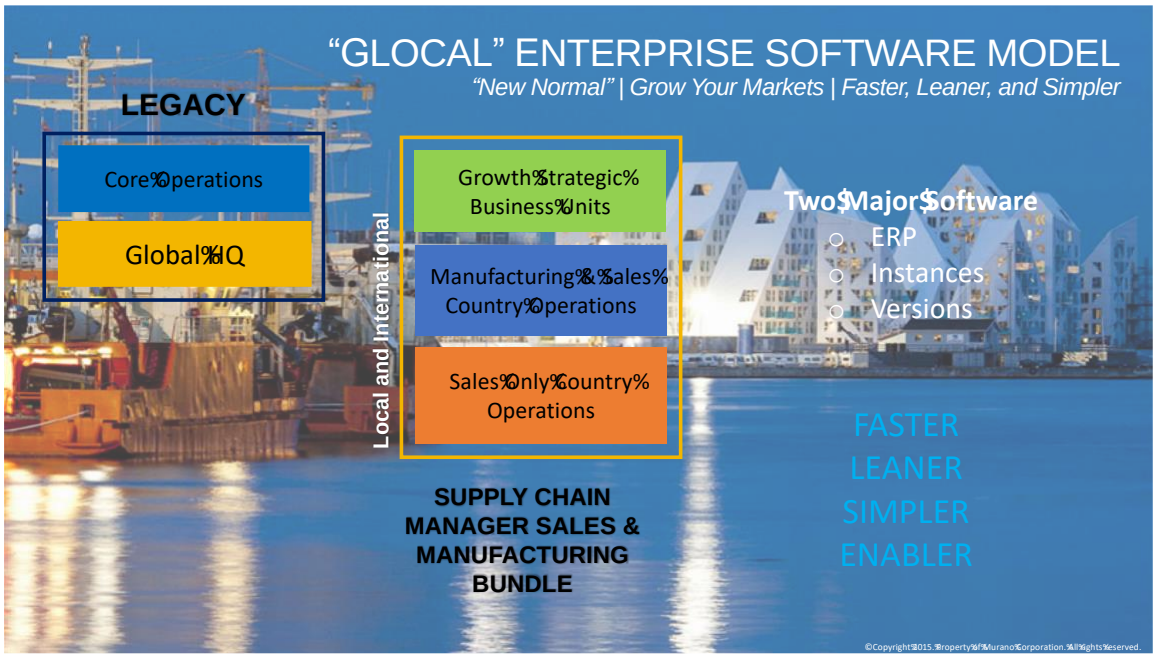
“GLOCAL” ENTERPRISE SOFTWARE MODEL: “NEW NORMAL” | GROW YOUR MARKETS | FASTER, LEANER, AND SIMPLER

Multinational enterprises are experiencing a trifecta of fierce domestic competition in Growth Markets, zero (or in some cases, negative) growth rates in the developed world, and an inherent lack of Operational Agility. Any response to the trends, whether it is a Globalized local (or “Glocal”) approach to the Growth Markets, combining the best of the developed and developing worlds, improving operational efficiencies, or adopting Cloud Technology to improve Operational Agility, are constrained by these multinationals’ legacy Enterprise Resource Planning (ERP) implementation. Legacy ERP software is old technology, slow to implement and adopt and adapt, time and resource consuming, inflexible, and distracting from the core competencies of these organizations. The legacy ERP is slow, heavy, complex and often times paralyzing. Introducing Industry 4.0 to a world of Legacy ERP that is many decades old is like mixing oil and water; adoption is a significant challenge. The external factors, combined with internal challenges caused by the legacy ERP, have led to an existential threat to the Multinationals – the “New Normal”. Can these multinationals survive the trifecta of Growth Markets competition, slowing Developed Markets, and a lack of Operational Agility? And can they adopt Industry 4.0 fast enough to overcome these challenges?

Figure 3: "New Normal" for Multinationals

“Glocal” Enterprise Software Model is a non-invasive and non-disruptive approach for Multinationals to handle this existential threat. It is a 2-speed model: the Global Headquarters and core business units in developed markets operate on legacy ERP, while the new growth units in developed and growth markets adopt a faster, leaner, and simpler cloud technology that is a true business enabler. With such a model, enterprises normalize, rationalize, and reduce the often out of control technology spending and footprint. Multinationals can become more operationally efficient by

adopting cloud technology thanks to “Cloud Economics” and the associated shift from Capital Expenditures (CAPEX) to a more subscription based (OPEX) model. Cloud technologies are faster to implement and agile to allow larger organizations to keep up with their nimbler Asian competitors with significant labor cost advantage. Cloud is also a key building block in the multinationals’ adoption of Industry 4.0. No Cloud, no Industry 4.0.



MURANO CORPORATION’S ENTERPRISE CLOUD SOFTWARE FOR INDUSTRY 4.0: *SUPPLY CHAIN MANAGER*

Just as the Internet of Services is the foundation of Industry 4.0, your company’s Enterprise Resource Planning software is the keystone of your Internet of Services. The ideal network architecture allows you to scale up seamlessly, integrates customizable inputs and outputs, and puts each department and organization in a value chain onto the same platform, reducing mistakes in transference.

Murano Corporation’s flagship offering, *Supply Chain Manager*, is a next-generation Enterprise Resource Planning Cloud software. It is an integrated, scalable platform with support for Sales, Purchasing, Manufacturing, Finance, and Human Resources functions. *Supply Chain Manager* is a multi-tenant, on-demand architecture, providing customizable, real-time updates to critical information across every value-chain department. Organizations can now focus on their core competencies and strengths, competing more effectively without being inhibited by incompatible platforms and expensive maintenance fees.

Supply Chain Manager is a true cloud computing solution, meeting all four criteria as defined by the National Institute of Standards and Technology (NIST):

- Ubiquitous
- Convenient
- On Demand Network Access
- Shared Pool of Configurable Computing Resources (e.g. networks, servers, storage, applications, etc.) that can be easily and quickly allocated with minimal effort.

The last point is the most critical when determining if a platform is truly cloud computing, and *Supply Chain Manager* was organically developed and purpose-built from the ground up to be a true multi-tenant solution. Cloud means convenient but secure global access to your company's critical information in real-time is now possible. Powerful executive reports, dashboards, analytics to make faster decisions mean that management can monitor their value chains, including all customers, suppliers, logistics providers, and employees easily. *Supply Chain Manager* is a key building block for Industry 4.0.

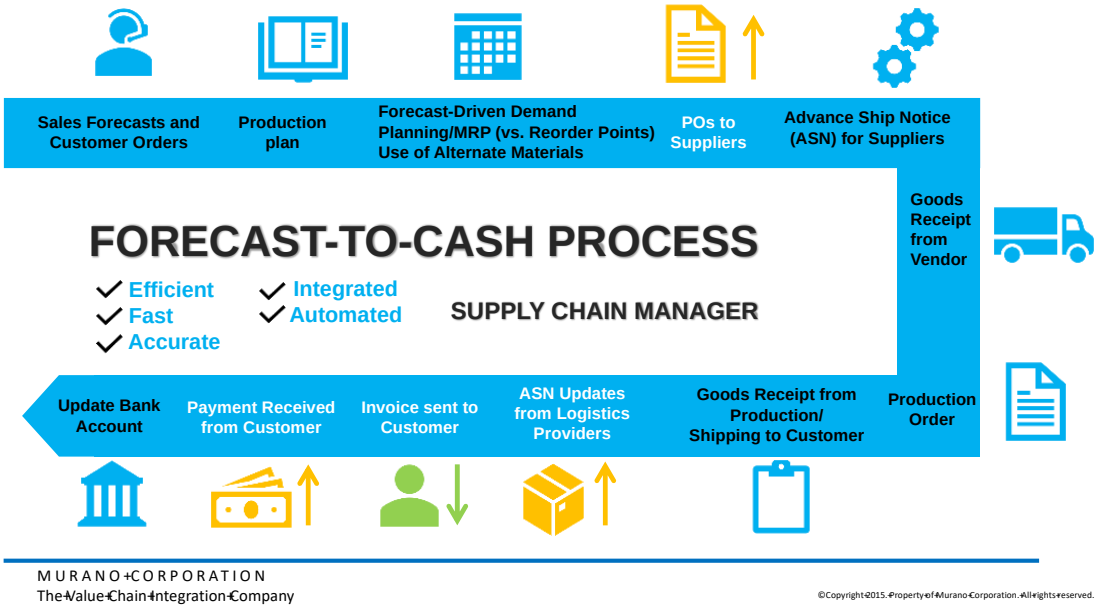


Figure 4: Industry 4.0 Implementation with Supply Chain Manager; More Automation, Accuracy, Integration, Speed, and Efficiency

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