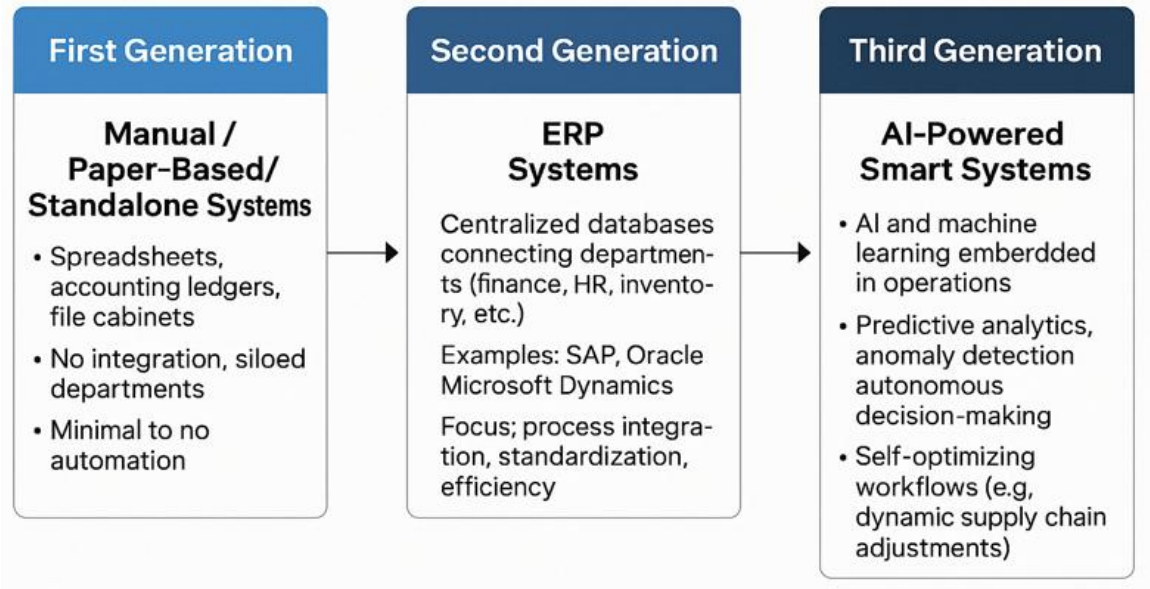
Smart Operations Management Systems

Dr Peter Green

Introduction

Smart Operations Management is the science of using technology to assist people in the art of operations management. Smart Operations Management Systems (SOMS) are the technology that implements Smart Operations Management.

SOMS are the next generation evolution in industrial IT (Information Technology) eco-systems after ERP (Enterprise Resource Planning) systems.



In this paper, we will look at the forces that are driving the adoption of SOMS, first as an extension of existing ERP systems and then as the eventual replacement for these systems.

Operations Management

Customer Order Processing

Supply Chain Management

Regulatory Compliance

Then we describe why intelligent agent technology will drive SOMS and not regenerative AI and finish by looking at the SmartOps247™ software platform and its applications. This software has evolved from an early US Department of Defense project at MIT to a system that is being used today for a wide range of applications, including efficient management of manufacturing plants and warehouses, customer order processing, supply chain management, and ensuring the safety of our pharmaceutical, food, cosmetics, and medical supply chains.

The Operations Management Problem

Circa 2000, I had a client that made products to stock based on a long run manufacturing model. They made a limited range of products, which they stored in a warehouse. They then shipped customer orders from stock and occasionally made more products when inventory in the warehouse ran low.

At that time this client had about 100 people on the floor and in the warehouse with about 20 people managing operations in the front office.

Then China joined the WTO (World Trade Organization) in 2001 and started to flood the US Market with look-alike products, which they were able to make at lower cost because they had lower labor rates and were very good at manufacturing.

In response, this client just like most of the manufacturing plants in the USA, switched to make-to-order manufacturing, where they made small batches or individual products, on a quick turn-around basis, to take competitive advantage of the 6 weeks it takes for an ocean-freight container to get from China to the USA.

This was fortuitous because of the arrival of the “Amazon Effect”, whereby consumers and then businesses came to expect delivery of a vast array of products, ordered on-line, in a few days. But by 2015 or so, the Chinese were starting to catch up in make-to-order manufacturing, especially for goods that could be air-freighted, and, as a result this client switched their shop-floor to highly automated machines, run by just 6 people, with 4 people in the warehouse to remain cost competitive.

At the same time, the front-office staff of this manufacturing plant had swelled to 32 people, managing just 10 people. So, the problem, like for many other plants in the USA, became the overhead cost of people to manage their operations and also the resultant inefficiencies.

Along the way this organization had acquired an ERP system to try to improve the efficiency of their front office operations but found that their Enterprise Resource Planning system, like all other ERP systems, was basically designed around accounting and MRP (Materials Requirements Planning) systems for long-run manufacturing. As a result, this increased rather than decreased the number of people needed in the front office.

To solve this problem, this privately held plant sold out to a large overseas conglomerate, which closed the plant and moved the production elsewhere mostly, to Mexico.

In this white paper, we suggest an alternate route, which is to use SOMS technology to enable more efficient operations with a smaller number of “overhead” staff in the front office. After all, the shop-floor was running very efficiently, producing more output to order than they had ever made before, with shop-floor labor being an insignificant part of their cost. But the front-office cost was making them non-competitive.

Reasons for Front Office “Bloat”

When we look at the roles performed by people in the front-office of most manufacturing plants and industrial distribution warehouses, we find that they are doing what sound like very important roles, including:

- Customer Support
- Order Processing
- Materials Supply Chain Management
- Production Scheduling and Planning
- Production Management

- Warehouse Management
- Shipping and Logistics
- Manufacturing Engineering
- Information Technology
- Quality Control and Regulatory Compliance
- Human Resources and Staffing

While these seem all very important and critical, when we examine what these people are doing, in detail, are:

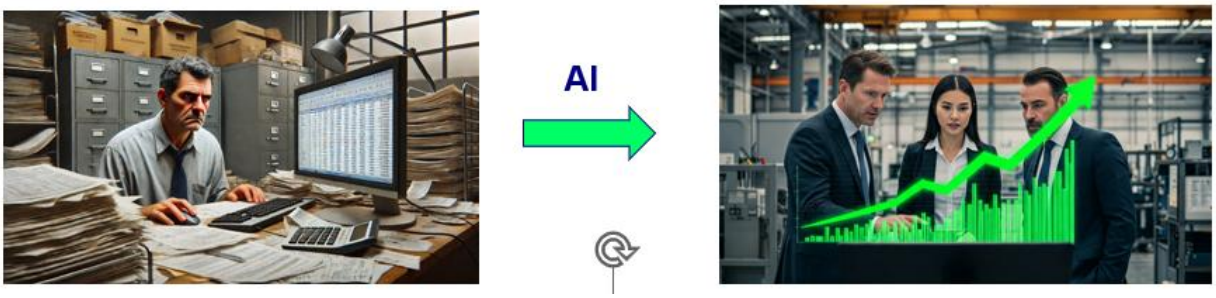
- Entering Data into Computers
- Answering Emails and Phone
- Sending Emails
- Attending Endless Meetings
- Reading Reports
- Analyzing Data
- Generating Reports
- Walking the Floor to Spot Problems
- Supervising People
- Advising People
- Understanding Regulations

As a result, many of these roles can be augmented or replaced by intelligent agents, which do the work of these people or supplement their roles by providing decision support.

Probably the biggest waster of time in the front office is complying with regulations from a myriad of state and federal agencies, preparing and sending reports. Last year there were over 86,000 pages in the Code of Federal Regulations (CFR) alone, which amounts to a stack over 20 stories high.

Fortunately, much of the work in handling these regulations can be delegated to SOMS intelligent agents, as can much of the increased workload in handling quick-turn short-run manufacturing jobs and the chaos resulting from the break-down in the global supply chain.

Application of Artificial Intelligence (AI)



Artificial Intelligence (AI) can be used to perform much of the "Intelligent Grunt Work" tasks required for industrial operations management, including:

- Automated Data Analysis
- Decision Support – Advisory Information Presentation
- Automated Updating of Systems
- Generation of Email and Text Message Alerts
- Relieving People of Tedious Paperwork, Spreadsheets, and Manual Data Entry

There are many different algorithms which come under the umbrella of AI, including Regenerative AI such as is used by software such as ChatGPT and Real-Time Intelligent Agents which are used by SmartOps247. The question is: which methods to use for implementing smart operations management systems?

Regenerative AI systems, which are all the rage now, are based on statistical self-adapting non-linear matrix correlators.

These matrix correlators are very useful for searching the internet for information, especially specifications and regulations, generating first-cut synopses of long articles, recognizing and generating images.

But they have great limitations, as they are statistical correlators and we all know, when making management decisions, that there are "lies, damn lies, and statistics" because correlation is not causation.

Also, they have no sense of time, space, sequence, or process as shown by the image shown at right, generated by the DALL-E3 regenerative AI algorithm when requested to generate an image of 3 people looking at a graph on a computer screen.

For this reason, in industrial settings, regenerative algorithms are best used for recognizing images. But even then, these should not be used without review by a human being, in critical situations, or by other algorithms when appropriate.

Regenerative AI algorithms will definitely not replace managers in making decisions. The primary reason is the size of the needed training set.

To train a self adapting correlator, you need to feed it a sequence of inputs and have a person tell the system what the input image represents, such as dog, cat, kangeroo, which the correlator uses to adapt its matrix coefficients. To get high accuracy you need a big correlation matrix and many training samples, which is why algorithms such as ChatGPT attempt to use the Internet as a training set.

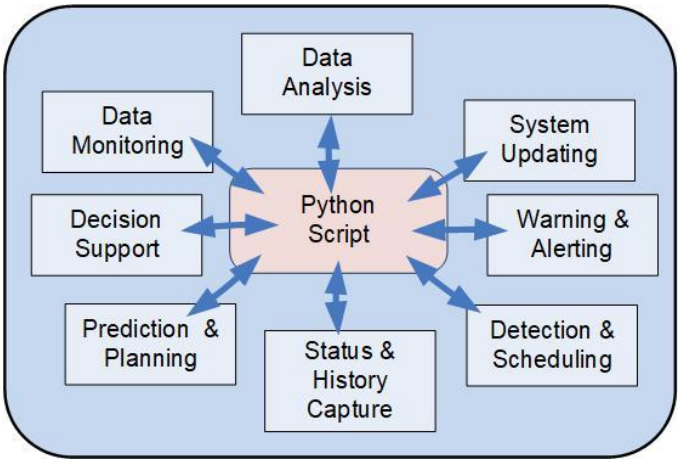
It has, however, taken human beings over 25 million years, with training inputs every 100 milliseconds or so, with severe pruning of the results through countless wars, for people to learn how to form management hierarchies. This is how long it has taken to learn this capability as we evolved from primitive lobster-like species, in the Miocene, over 25 million years ago. This is obviously not feasible in an industrial setting.

Also, it takes hours or days of time on huge expensive supercomputers, to generate a correlation matrix from selected portions of the Internet. Then it takes minutes of expensive computer time to query the correlation matrix to get an approximate answer. Again, this limits the feasible applications due to cost, as well as accuracy considerations.

Fortunately, there is an answer to this problem, which is to use real-time intelligent-agent technology, that was originally developed for applications such as advising pilots about how to complete their missions despite battle damage to their aircraft and today is used to detect counterfeit pharmaceuticals as well as contamination and bioterrorism in the food supply chain.

This intelligent agent technology is now being extensively deployed in industrial smart operations management applications.

Agents are independent computer processes, which can be run in parallel on a multi-core computer to handle many operational events at the same time. These agents work together to solve problems iteratively and understand time and distance.



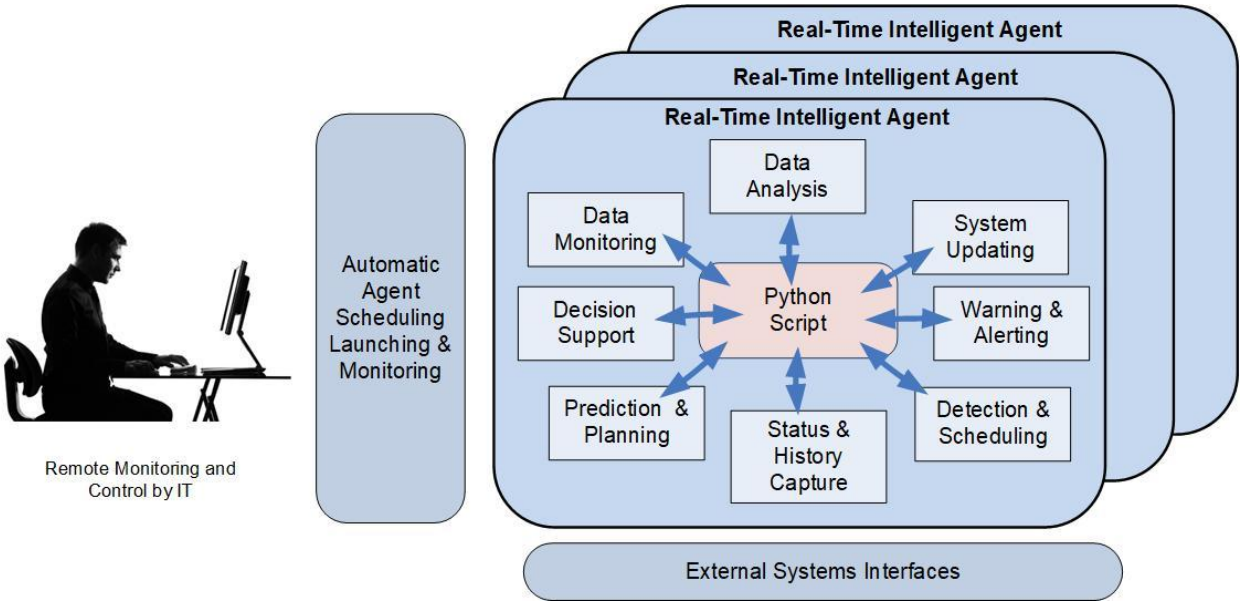
These agents use deterministic decision-making algorithms such as:

- Rules
- Decision Trees
- Mathematical Algorithms
- Predictive Filters
- Clustering

which are understandable and independently testable, which make them ideal for use in an industrial environment, where operational control is essential.

SmartOps247 Platform

Intelligent agents need to be run periodically to monitor sources of data and to turn this into actionable information. This can be done using a software platform, such as the SmartOps247 platform, which can launch intelligent agents in parallel in near real-time to carry out a wide range of functions and then monitor them to make sure they are running correctly.



SmartOps247 typically provides over 90% of the needed code for most Real-Time Smart Operations Management System (SOMS) applications, with the rest provided by Python scripts, which are used to tailor the actions of the intelligent agent processes to the specific needs of each enterprise.

These agents run continuously 24x7, hence the SmartOps247 name, and can run on small ruggedized Window IOT (Internet of Things) Enterprise computer for reliability. Alternately SmartOps247 can be run on a Windows Server in an enterprises data center.

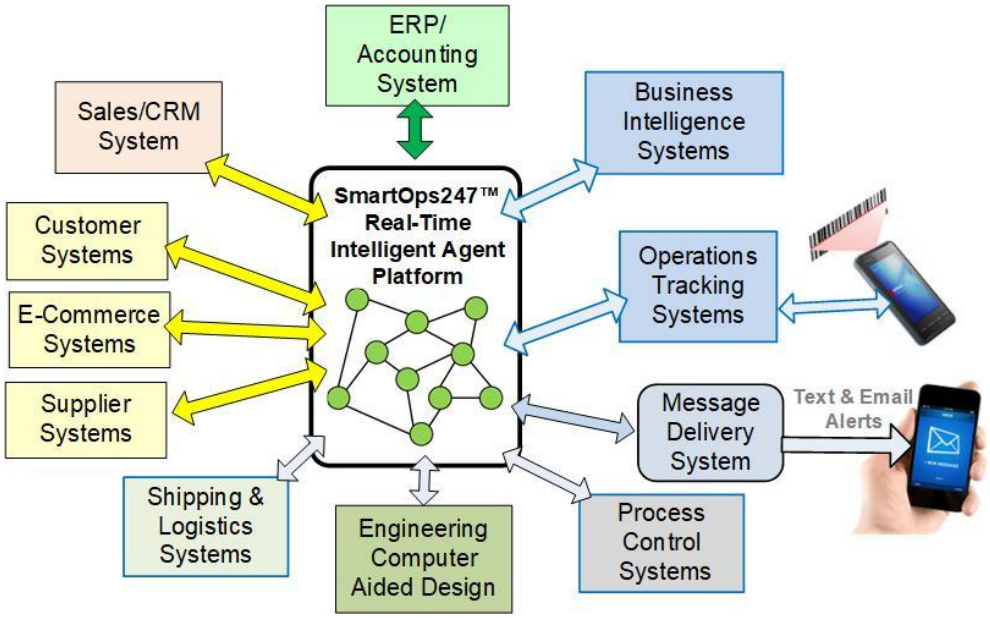
The SmartOps247 platform has a variety of external interfaces built in, including for different databases, web-services interfaces, and messaging services. These can be accessed by simple calls to subroutines in the Python scripts thus avoiding much of the complexity in implementing intelligent agents which need to communicate with external systems.

Combined with the integral SmartOps247 smart operations management database, these interfaces can use store-and-forward methods to ensure reliable information delivery to other systems and to people despite unreliable communications over the Internet.

SmartOps247 comes with an automated agent scheduling, launching and monitoring facility which helps ensure continuous 24x7 operation for long periods of time. It also comes with an interface for IT people to remotely monitor SmartOps247 and intervene when there are issues, such as with external systems interfaces become unavailable.

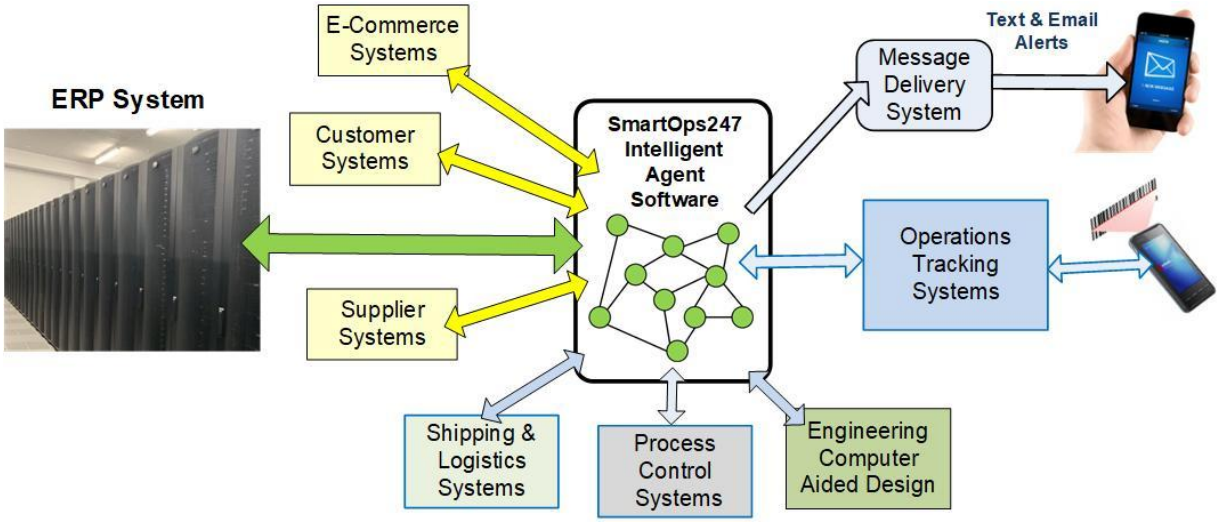
Applications of SmartOps247

Integrating the Industrial Enterprise



Here the purpose is to make sure that all stake-holders have the information they need in the format they need it, when they need it, in order to do their jobs efficiently.

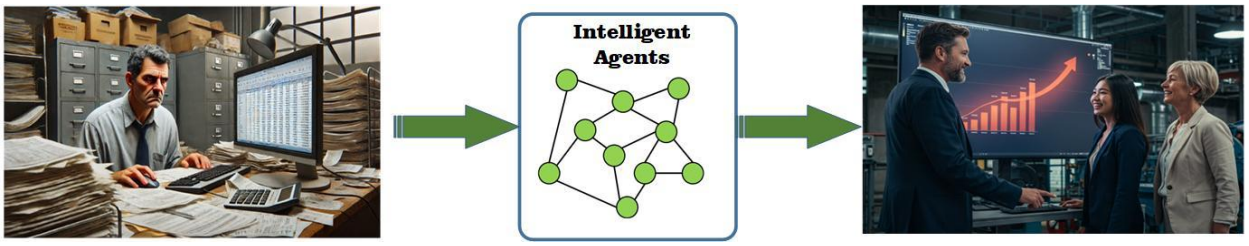
ERP Enhancement



AI Based Smart Operations Management Software is currently used to supplement legacy ERP systems but will eventually replace most of their functions, except possibly accounting.

ERP systems were designed for use in long-run, make-to-stock manufacturing plants and do not have the capabilities needed for short-run, quick-turn, make-to-order manufacturing and industrial distribution organizations.

Smart Operations Management

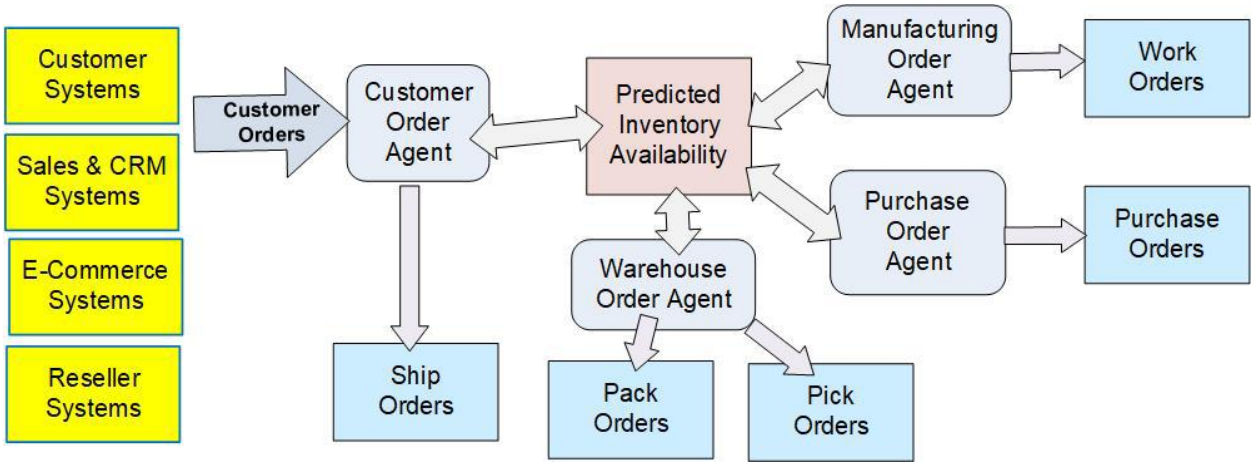


Intelligent agents can replace much of the "Intelligent Grunt Work" performed by managers and their staff, freeing them up to focus on managing and not paper-pushing. In doing this the intelligent agents run 24x7 to automatically:

- Analyze data from one or more sources
- Make routine decisions
- Monitor processes, inventory, and customer order status
- Provide advice or generate alerts
- Update other systems

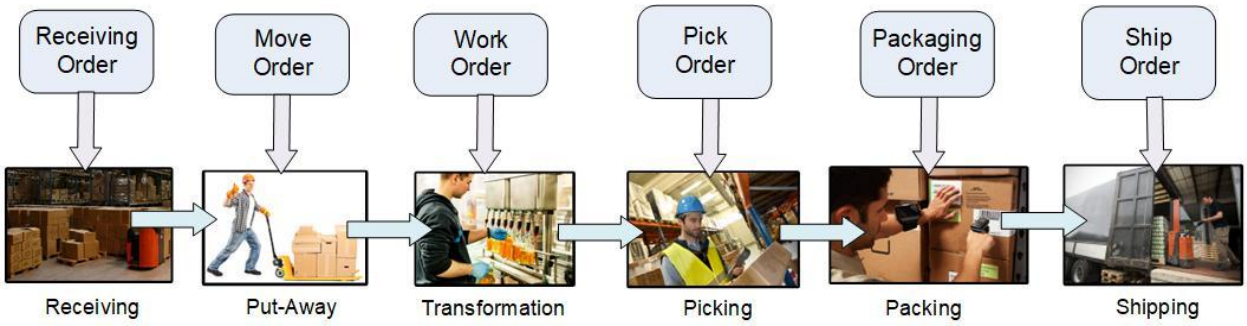
Use of intelligent agents can result in labor cost savings from $60,000 per year to over $1 million per year per site, enabling these systems to rapidly pay for themselves.

Processing Customer Orders



These days customer orders continuously flow in from a wide variety of sources, including:

- Direct feed from customer and reseller systems, usually by EDI
- Entry by sales people into the organization's CRM system
- E-Commerce systems including the organizations own website(s)
- Drop ship orders from third party E-commerce systems



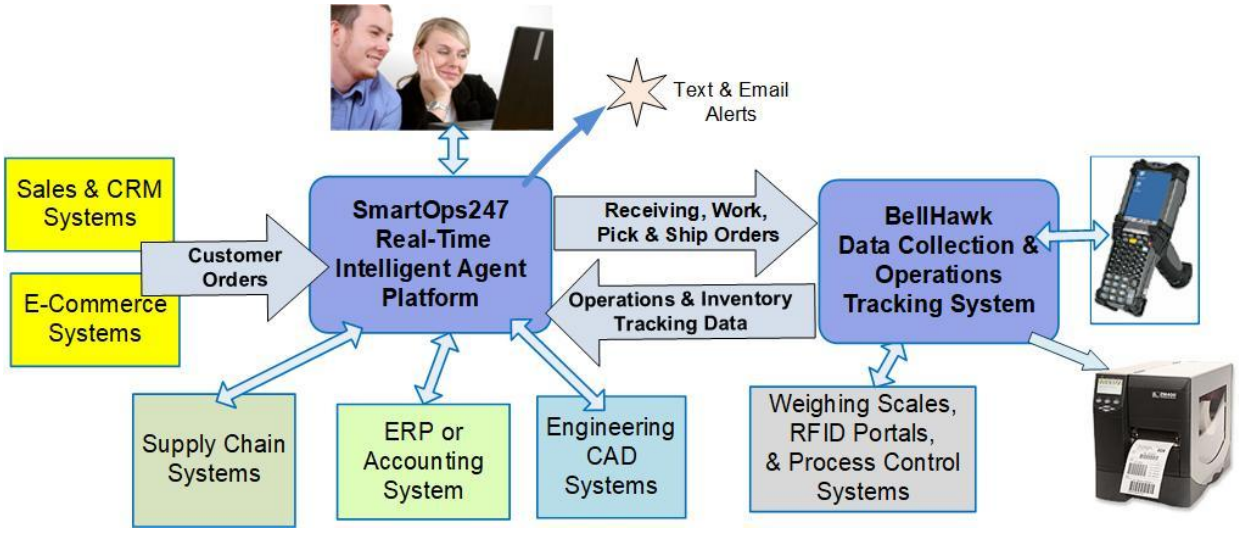
These customer orders all have to be converted into work orders to make the needed products, as well as pick, pack and ship orders, to ship the finished products to customers. In addition, the available levels of needed inventory have to be predicted and purchase orders issued to suppliers and receiving orders issued to the warehouse.

Doing this manually, especially with short delivery times and a wide variety of products, can require an enormous amount of labor and can be the cause of frequent mistakes. Fortunately, for the most part, these order generation tasks can be delegated to intelligent agents.

Please note, however, that unlike doing materials requirements planning using the MRP function of an ERP system, here planning and scheduling takes place in near real time, as new orders flow in and the status of manufacturing and warehouse operations change dynamically.

Intelligent agents can also automatically notify customers and ordering systems when the status of their orders change, thus saving on customer support responding to inquiries about order status.

Data Collection Integration



Intelligent agents depend on real-time data to generate real-time information and make real-time decisions. To this end, Smart Operations Management Systems often are integrated with systems that collect and track operational data in real-time.

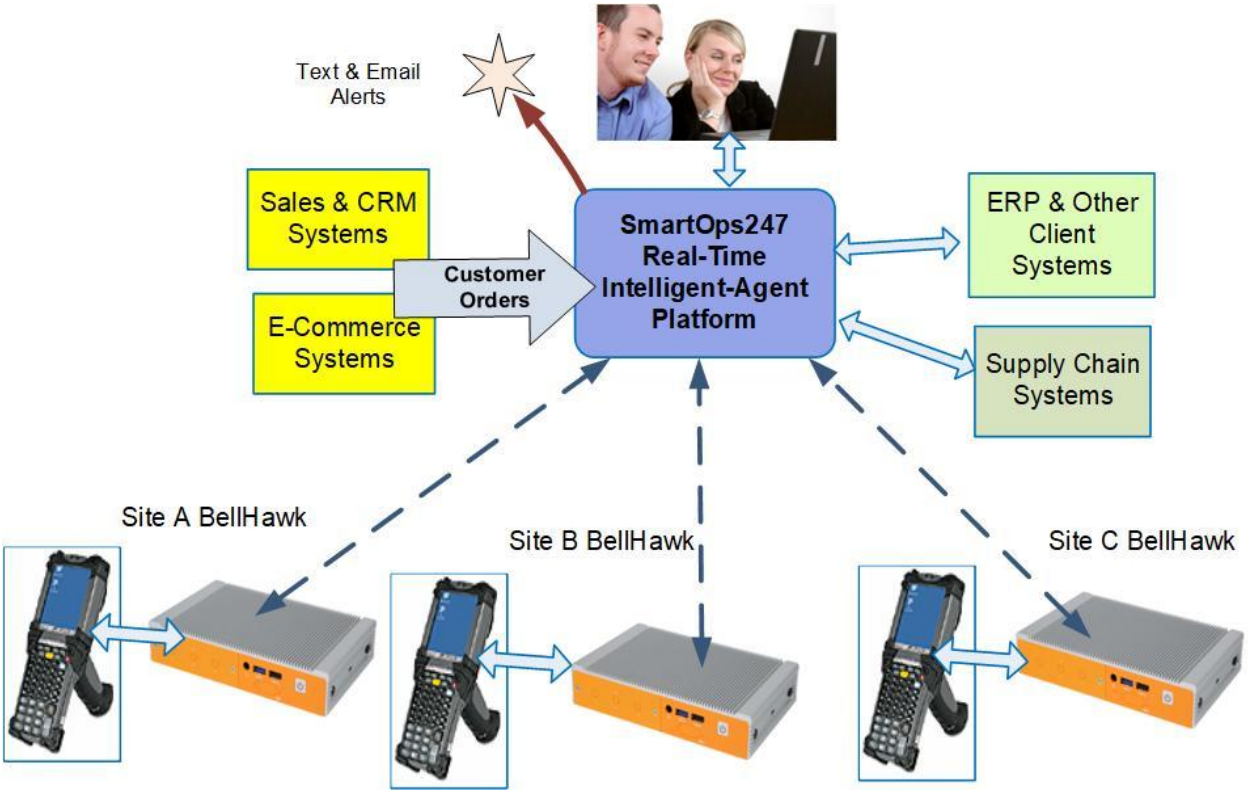
With the SmartOps247 based systems, this function is often performed by the BellHawk barcode and RFID data collection and operations tracking system.

In addition, SmartOps247 can be integrated with warehouse management systems (WMS) and job tracking systems, as well as process control lines and test stands as sources of data.

With such an integration, SmartOps247 agents send orders to the data collection system, for carrying out by shop floor and warehouse personnel. In exchange the SmartOps247 receives back operational status data which is placed in the SmartOps247 Operations Management database, for use by all the agents.

This operations management database is where the current status of orders and operations is maintained by the intelligent agents for their own use, as well as for use by third party Business Intelligence (BI) systems. These BI systems can access the contents of this database to visualize and process the contents of this database through a secure web-services interface. This can be done over the Internet as well as through the organizations own network.

Multi-Site Integration

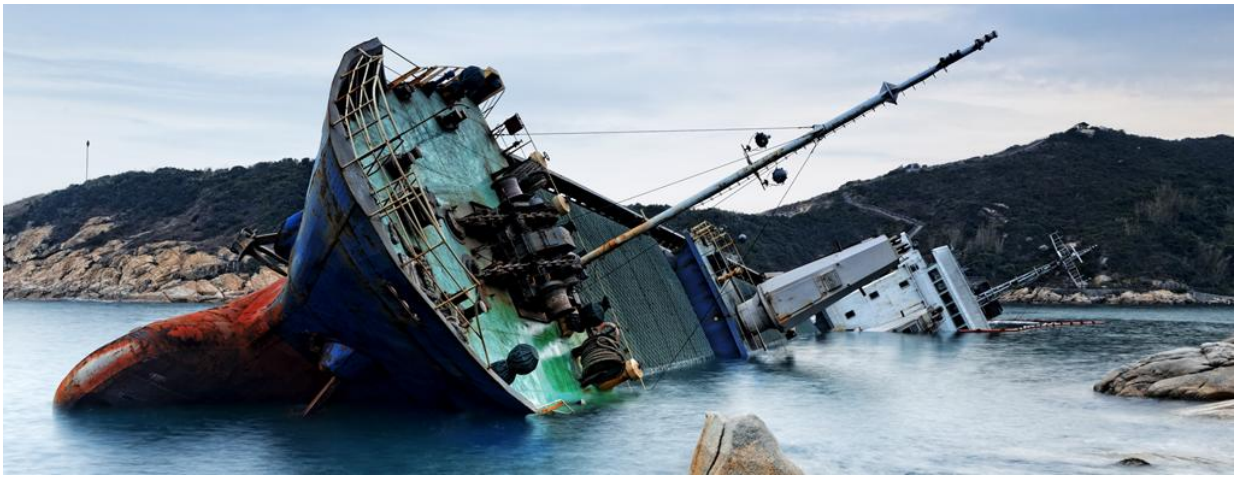


SmartOps247 can integrate operations at multiple manufacturing and distribution sites.

Here customer orders can be automatically converted into manufacturing and distribution orders and automatically routed to the appropriate sites, depending on capability, capacity, closeness to the customer, and possibly import and export duties.

SmartOps247 then provides a centralized business intelligence resource for senior management, including alerting them when there are situations that they need to pay attention to. This same data can then be used to update the corporation's ERP system, as well as exchange data with other supply chain partners.

Supply Chain Management



It used to be simple. You purchased the parts you needed from the same set of distributors and used their manufacturers' part numbers in the BOMs (Bills of Materials) for the products that you manufactured. Raw material parts were ordered as needed and intermediate inventory was made from these based on projected demand.

Then the global supply chain started to collapse. All of a sudden, reliable suppliers had stock outs and were quoting 6-month lead times for critical parts, if you were lucky. As a result, you had to source substitute parts from alternate suppliers, with different manufacturers part numbers, in different per-pack quantities, different incoming QC requirements, and with no certainty that the parts would arrive when promised.

All of this dramatically increases the work load in managing the incoming material supply chain, made all the worse by the rapidly fluctuating customer demand for make-to-order products.

Fortunately, Intelligent Agents can:

- Track inventory and received materials
- Project pending demand and potential shortages
- Send alerts when inventory is projected to fall too low
- Automatically generate POs and submit these to suppliers
- Communicate with supplier systems to track order status
- Track deliveries and send alerts when materials fail to arrive on time
- Reallocate inventory to different plants as needed.
- Handle receipt of substitute parts with different manufacturers part numbers
- Handle common expediting task automatically
- Automatically exchange Electronic Data Interchange (EDI) messages with suppliers relative to expected lead times, available inventory, and order tracking.

FDA Regulatory Compliance

Intelligent agents are already playing a major role in ensuring the safety of our pharmaceutical, medical, and cosmetics supply chains. With new regulations, they are expected to play an ever-increasing role in enabling the rapid recall of contaminated materials from our food, beverage, and nutraceutical supply chains.

The SmartOps247 software platform is already playing a role in helping detect problems in the above supply chains as well as providing the information to ensure rapid recall of defective materials. In this role SmartOps247intelligent agents can:

- Track and maintain the history of materials tracking and traceability event data
- Exchange traceability data with upstream & downstream partners using EPCIS and EDI 856 files
- Detect counterfeit products
- Support recalls through supply-chain trace back and trace forward algorithms

Manually maintaining and exchanging supply-chain traceability data with upstream and downstream supply chain partners can require an enormous amount of peoples' time, which is expensive and is error prone.

Even worse, when a problem with defective or contaminated materials arises, the failure to have accurately maintained the required supply chain materials traceability data have resulted for a significant number of manufacturing companies in very expensive product recalls, fines, criminal prosecution of senior management, and bankruptcy.

By automating the processing of materials tracking and traceability data, through the use of a Smart Operations Management System, such as SmartOPs247, the probability of such undesirable outcomes can be minimized.

Conclusion

It is now feasible and practical to integrate Artificial Intelligence into Smart Operations Management Systems using real-time intelligent-agent software platforms, such as SmartOps247. These systems can quickly pay for themselves in reduced overhead costs in the form of labor savings as well as improved operational efficiency, improved customer service and the prevention of expensive mistakes.

Author

This white paper was written by Dr. Peter Green, who serves as the Technical Director of a number of software companies. Dr Green obtained his BSC (Hons) in Electrical Engineering and his Ph.D. Degrees in Electronics and Computer Science from Leeds University in England. Subsequently Dr. Green was a senior member of technical staff at Massachusetts Institute of Technology and a Professor of Computer Engineering at Worcester Polytechnic Institute.

Dr Green is a Systems Architect who is an expert in using real-time artificial intelligence methods to implementing real-time operations tracking and management systems for industrial organizations. He has led the implementation of over 100 such systems over the past decade. Dr Green also led the team which developed the SmartOps247 real-time artificial intelligence software platform and the BellHawk operations tracking software.

For further discussion, or to send comments, please contact peter.green@SmartOpsMgt.com.

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