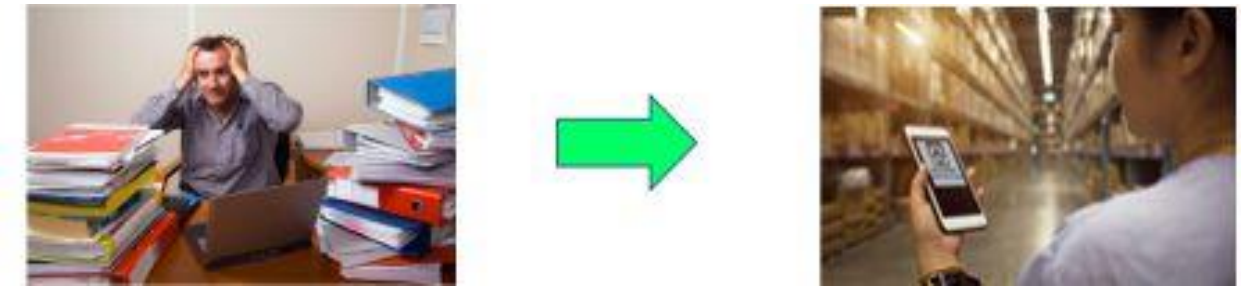
Using Artificial Intelligence to Upgrade your ERP System

A White Paper by Dr Peter Green



Introduction

This white paper addresses two groups of people:

1. The senior management of manufacturing and industrial distribution organizations who are contemplating purchasing a new ERP System.
2. The same people who now are having buyer's remorse by purchasing an expensive ERP system only to find that it does not meet the needs of production operations management.

This white paper is focused on addressing the needs of production operations managers and their staff in manufacturing plants that specialize in short-run, quick-turn, manufacturing of semi-custom products. Such plants comprise the bulk of the 60,000 or so mid-sized manufacturing plants in the USA. Of these, an estimated 50,000 plants are still capturing their operations tracking data using paper forms followed by manual keyboard data entry into their ERP systems.

For a production operations manager, some of the scariest words from their CFO are "I have just brought you a new ERP system", implying that the new system was purchased without consultation with the production operations management staff. Typically, such a system meets all the accounting requirements for the organization but inevitably it does not meet the needs of the managers that have to make and ship products.

In this white paper, we examine typical shortcomings of ERP systems, from an operations management viewpoint, and then propose how many of these issues can be overcome by using AI based software, such as that from KnarrTek, to turn an inadequate ERP system into a fully functional operations management system.

Typical ERP Shortcomings

Many manufacturing and industrial distribution organizations purchase an expensive ERP (Enterprise Resource Planning) system to run their operations, only to be disappointed in the outcome.

What they find is that:

1. ERP systems are basically accounting systems at their core with the addition of Materials Requirements Planning (MRP) algorithms. These systems typically include the ability to issue work orders, with a route of operations, to make products, along with a needed BOM (Bill of Materials). They also can issue Purchase Orders and capture Customer Orders, including handling Accounts Receivable and Accounts Payable functions.

2. ERP systems have a large number of very complicated screens into which to manually enter data. Because of their complexity these screens are not suitable for data entry by production workers or material handlers and has to be done by office personnel based on the use of paper forms written by production workers and material handlers. Also, every user requires significant training in how to use the system.

3. ERP Systems are great at producing volumes of reports about what happened yesterday but very poor about alerting managers in real-time when problems are occurring or about to happen.

4. The Materials Planning Algorithms in ERP Systems are only suitable for long-run manufacturing of standard products. They are not suitable for quick-turn manufacturing of semi-custom products. As a result, many ERP systems are used as glorified accounting systems and the generation of purchase orders and manufacturing work orders has to be done through manual data entry into the ERP system.

5. ERP systems track the quantity of each item at each location (usually large locations, such as warehouses because of the difficulty of recording movement within warehouses). They have to rely on external Warehouse Management Systems (WMS) for a more detailed record of the location of materials (such as on racks and shelves).

6. ERP systems with or without an attached WMS system are incapable of tracking assets, individual items or containers of material using LPN (license plate number) tracking methods, such as are used by Amazon, FedEx, and UPS, and which are the basis of the GS1 (Global Standard One) tracking standards, such as those adopted by the FDA for food and pharmaceutical traceability as well as other Government Agencies such as the Department of Defense.

7. ERP systems with or without attached WMS systems cannot track pallets containing different types of material. They also cannot track partial kits and the borrowing of parts from kits. Most cannot easily track dimensioned materials or the same materials in different containers at different locations.

8. ERP Systems do a very poor job of incorporating automated data collection methods, such as those using barcode, RFID, and mobile computing technologies. As a result, they

are unable to deliver point-of-action warnings when production workers and material handlers are about to make an operational mistake.

9. ERP systems do not incorporate production scheduling algorithms that are suitable for use in short run, quick turn manufacturing. Instead scheduling has to be done in time-consuming production planning and scheduling meetings.

10. ERP systems are large monolithic pieces of software that are complicated to develop and expensive to maintain. While most have limited configurability, almost all ERP systems these days cannot be customized for the needs of the individual manufacturing plant or industrial warehouse.

11. ERP Systems are complex to set up, difficult to use and require large amounts of training and external support, typically provided by expensive teams of external consultants.

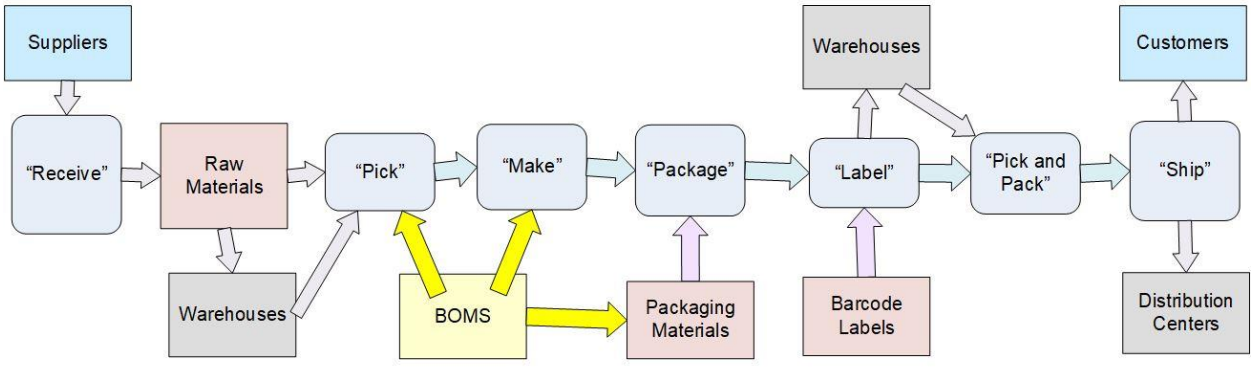
As an example of these issues, many years ago, I was part of a team that implemented a new ERP (Enterprise Resource Planning) system for a mid-sized high-tech manufacturing company. It took us about 6 months and, at the end of that time, we proudly walked into the CEO's office and showed him all the reports he could get from his new ERP system.

Instead of being pleased, the CEO scowled, pushed the stack of reports away, and said "What I need, every day, is one sheet of paper with the 6 most important things I need to pay attention to!" and, with that, stormed out of the office.

Most manufacturers and distributors seem to believe that they need an expensive ERP system to run their operations and yet most ERP systems are simply used as glorified accounting systems. Even worse, these systems do not come anywhere close to producing the CEO’s desired single sheet of paper to run the organization.

In this white paper, we look at the operations management needs of mid-sized manufacturing and industrial distribution organizations, how traditionally these have been served by ERP systems, and how the above problems may be solved by a adding a new generation of systems, such as those from KnarrTek, which use Artificial Intelligence methods.

Operations Management Needs



Manufacturers need to track and manage the receipt and put-away of raw materials and then track and manage the conversion of raw materials into finished products, through a sequence of

operations, including tracking intermediate products and WIP. They then need to track and manage the picking, packing, and shipping of the finished products. Parts of this material flow, involve the storage of raw, intermediate, and finished products in warehouses.

Today, even nominal Industrial Distributors, do secondary operations such as kitting, assembly, and repackaging for their customers, following the same flow as shown above.

In addition to this, manufacturers need to convert the incoming flow of customer orders into purchase orders to buy raw materials and intermediate parts and assemblies. They also need to generate work orders to convert raw and intermediate materials to finished goods, as well as to issue picking, packing and shipping orders.

Finally, managers and their staff need to plan, schedule, and coordinate all of this activity to make sure customer orders get shipped on time and to make sure that corrective action is taken as soon as problems arise.

Please note that managing and keeping track of Accounting, Sales Prospects, and Marketing is not part of this required set of activities.

ERP Systems

Enterprise Resource Planning (ERP) Systems have been around for several decades. They originally consisted of accounting systems, with the ability to do Materials Resource Planning (MRP) for one or more manufacturing plants. Over the past decade ERP vendors have added CRM (Customer Relations Management) and sometimes Marketing Support, although these are peripheral to the needs of manufacturers.

For accounting purposes ERP systems track inventory (the quantity of each item in stock) and the labor and materials needed to make products. For materials planning they need the Bills of Materials to make each product and intermediate material as well as the routes of operations needed to make products.

In doing materials requirements planning (MRP), most ERP systems start with several month's forecasts of the demand for each product and then compute how much of each material they need to order and make to meet this future demand. The plan is typically starts next month and assumes that the plan for this month completes as planned.

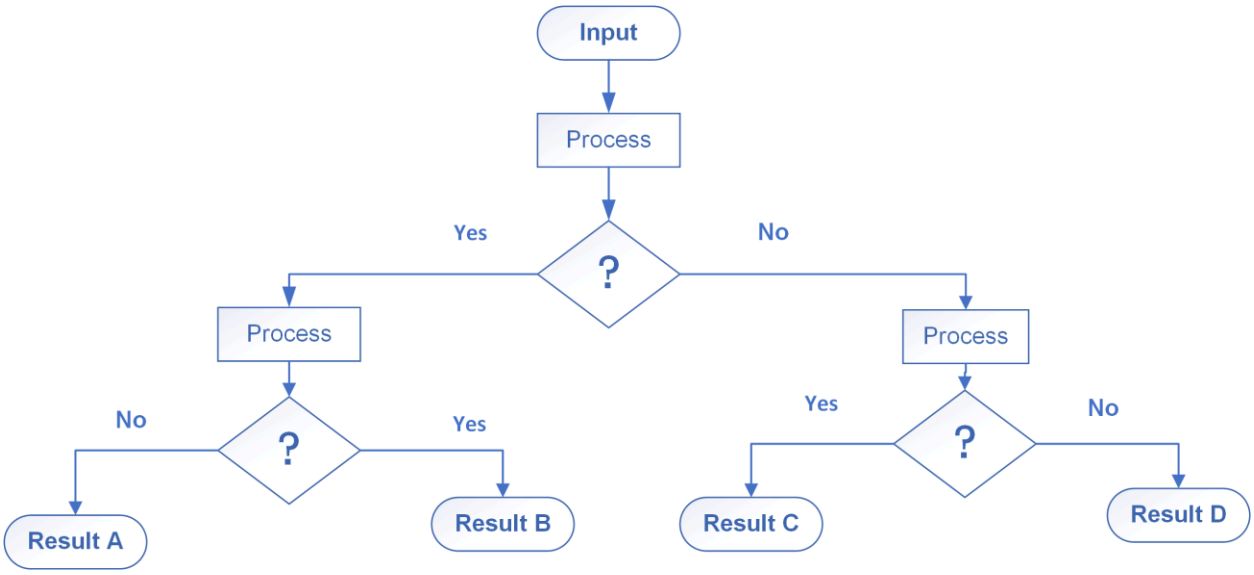
This works well, when the manufacturing plant is doing long-run manufacturing of standard products. It does not work at all well in a quick-turn make-to order manufacturing business where there is little or no future visibility of orders.

Most US manufacturers specialize in quick-turn make-to-order production of semi-custom products and, as such, most do not use the MRP functionality of their ERP systems. As a result most US Manufacturers use their ERP systems for recording financial transaction, including the count and value of inventory, as well as issuing purchase and work/manufacturing orders in response to customer orders.

Most data entry is done by keyboard, although some inventory data collection is done by attached WMS (Warehouse Management Systems) which use barcode scanning and mobile computers to improve the efficiency of data collection.

There were attempts to incorporate scheduling into ERP systems with the introduction of MRP2 but these depended on long-lead demand forecasts and a predictable availability of people and equipment resources. Again, while these worked in large automotive plants, such as those of Toyota, they were not appropriate for most American plants.

The biggest drawback to ERP systems is that nothing happens until someone sits down at a keyboard and enters some data on a screen.



ERP systems tend to be large monolithic systems which follow a decision tree coding mechanism, as shown above, with subroutine calling subroutine, calling another subroutine and so forth until some result is achieved. Modifying any one part of the decision tree requires regenerating a whole new program and distributing this to all users to install on their computers.

This makes these systems expensive to develop and hard to modify to meet the needs of each individual organization. As a result, ERP systems tend to be "one-size fits all" which is great for accounting systems but not for meeting the diverse operating needs of many different organizations.

KnarrTek Technology

KnarrTek provides three software platforms that, when used in conjunction with an ERP system, can solve many of the above problems. These are:

1. The BellHawk Job and Materials Tracking System, which uses technologies such as barcode and RFID scanning to track operations and materials in manufacturing plants and industrial distribution warehouses in real-time.

2. The MilramX Enterprise Integrator software platform, which intelligently moves data between systems and people to ensure that people they have the information they need, to do their jobs, when and where they need it.

3. The KnarrTek ICOM Industrial Customer Order Management System which integrates customer orders from multiple sources and then generates the needed purchase orders and manufacturing orders to buy and make the materials needed for customer orders.

All three are based on rules-based real-time expert systems technology and on real-time intelligent agent technology.

Rules Based Expert Systems

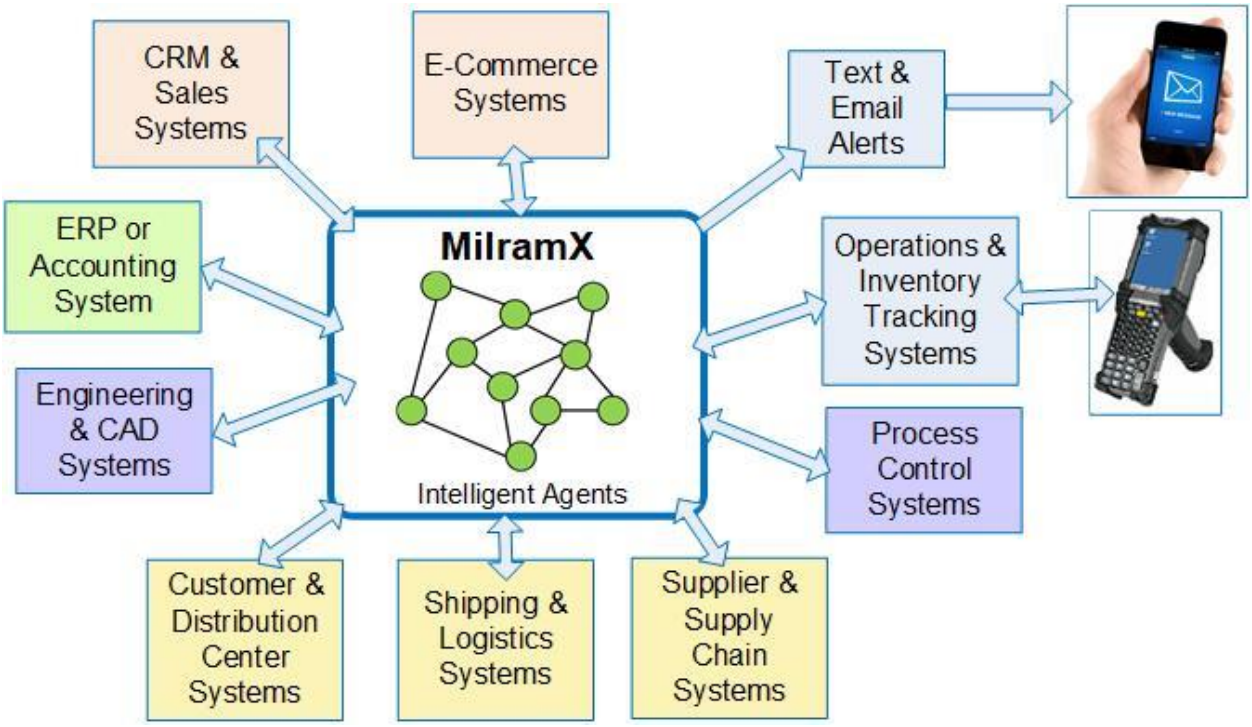
In a rules-based expert system, the actions of the system are controlled by a set of IF….THEN…..ELSE… rules. In the KnarrTek software platforms, the structure of the rules is based on best operations management practices which, as standard, is fixed in the code, but the parameters of the rules can be imported using Excel spreadsheets. This enables, for example:

1. The software to be easily configured to meet the needs of each specific organization.
2. The data captured by BellHawk to be configured by clients with real-time point-of-action warnings when the user is about to make an operational mistake.
3. The contents of custom barcode labels, automatically printed on demand, to be specified for each specific situation.
4. The import and export of data to be configured to meet the needs of each organization.

The use of Excel spreadsheets to setup the rules, makes for a quick and easy deployment, enabling users to be able to use a BellHawk system to collect and view their application specific data within a couple of hours. But sometimes the built-in rules are not enough, such as in requiring application specific operational mistake warnings, in which case the staff of KnarrTek modifies the rules to meet the specific requirements of each user.

Some reports can also be configured using built-in rules, with user entered parameters. But where custom reports are required, these can be written by users as Python scripts.

Intelligent Agent Systems



Intelligent Agents are independently scheduled scripts (code snippets) that monitor database tables for new/changed entries and then:

1. Automatically update tables in one or more databases.
2. Send Alerts by means of Email or Text messages
3. Exchange data with one or more systems.

Some of the tasks that Intelligent Agents perform automatically include:

1. Importing and integrating customer order flow from a variety of sources, such as E-Commerce and other Sales Order Systems
2. Monitoring Inventory and reordering when below minimum inventory levels
3. Computing the incremental materials that need to be purchased and made for each customer order.
4. Issuing Purchase and Work Orders needed to purchase and make the materials needed for each customer order.
5. Scheduling and Planning Production to ensure, as much as possible, that customer orders get delivered on time/
6. Monitoring production and sending alerts if production falls behind schedule
7. Scheduling picking and packing of customer orders

8. Notifying customers when order is shipped.

Here all these actions take place without human intervention, which means that they can take place 24x7 whether people are at work or not. By not wasting 50% of their time on these "intelligent grunt work" tasks managers and their staff now have much more time to devote to the efficient running of their manufacturing operations.

KnarrTek Intelligent Agent Technology

KnarrTek uses Intelligent Agents in four ways:

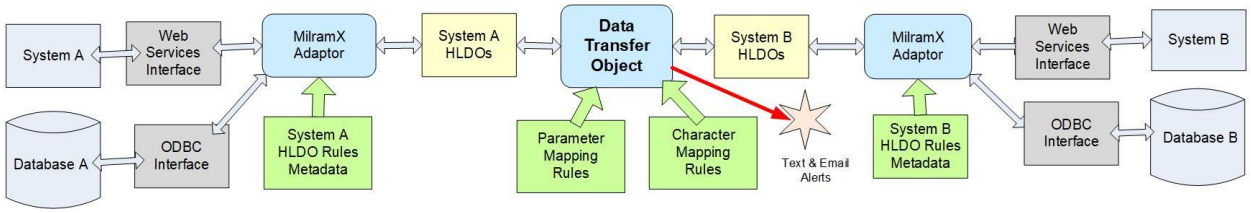
1. As part of the MilramX Intelligent Agent Software Platform which is primarily used for enterprise integration, including implementing intelligent automated data exchange interfaces between multiple systems, monitoring data sources, and sending Alerts when needed.

2. As part of its BellHawk Job and Materials tracking system, to monitor operations and to generate messages to managers and staff when there are situations that need their attention.

3. As part of the MDEX interface to BellHawk, which provides a store and forward interface between BellHawk, ERP and other external systems.

4. As part of the KnarrTek Industrial Customer Order Management System which automatically integrates customer orders from multiple sources and then creates the necessary purchase orders as well as work, pick, and ship orders that it sends to a BellHawk system for action.

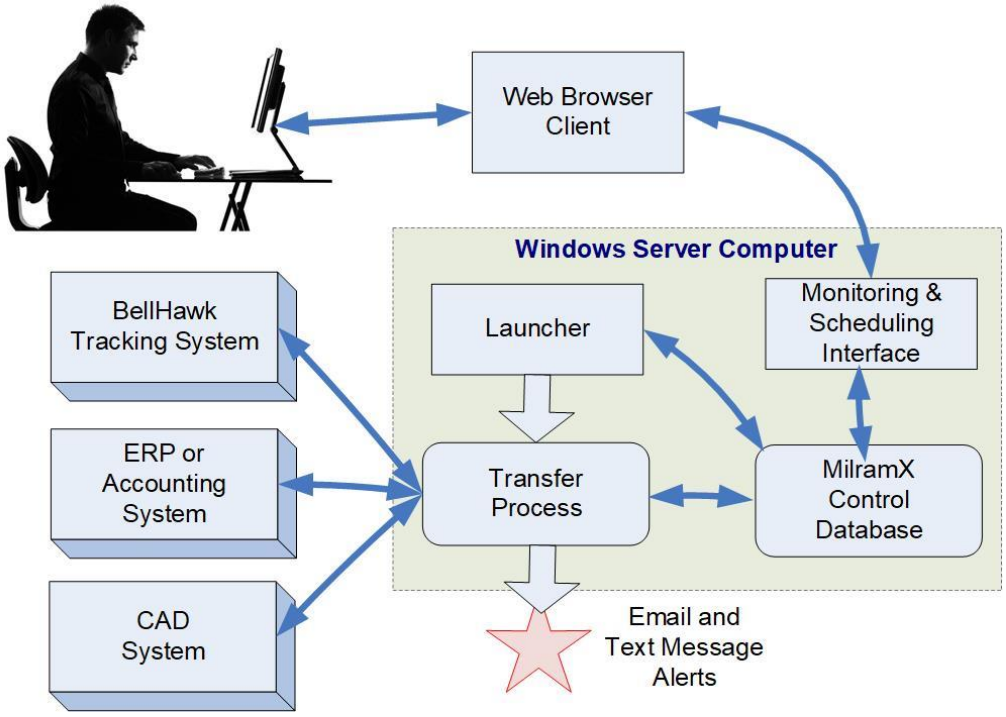
The KnarrTek intelligent agents are written as scripts, known as Data Transfer Objects (DTOs) in the simple-to-use Python language.



Within the MilramX operating environment, there are rules-based adaptors that translate between the complexities of external databases and other systems interfaces and High Level Data Objects (HLDOs), which are named sets of name:value attribute pairs (similar to JSON strings). This dramatically simplifies the writing of scripts as it reduces the complexity of interacting with external systems to Fetch (Latest Updates), GetNextRecord, and Store or Send(Alert) commands, with MilramX handling all the complexity.

In between getting the data and storing or sending the result, the Python script can be used to perform any level of data manipulation that is required. This can be as simple as moving data from a source HLDO to a target HLDO or using a Neural Network algorithm to learn some characteristic of the data, such as how long an operation takes, in real-time.

Within MilramX, DTO script execution is scheduled through a web-browser interface, with the schedules stored in a Control database.



A launcher process then schedules the execution of the DTO, retrieves the Python script from disk, along with a supporting package of MilramX modules, including the Adaptor code, and needed HLDO definitions, and launches a separate Windows process to execute the Python script. The launcher then proceeds to the next DTO in its queue.

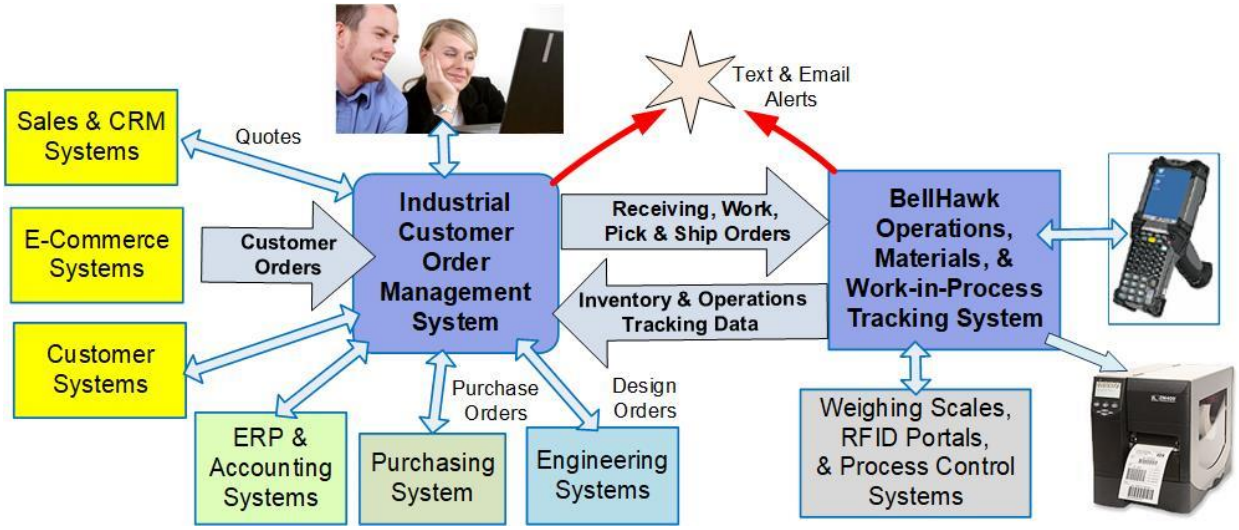
In this way multiple scripts can execute in parallel, some taking a short time and some taking a long time to run depending on the amount of data they need to process and the complexity of the analysis to be performed. As each DTO runs and completes, it writes its status in the control database, enabling its status to be monitored through the web-browser interface.

When each DTO process terminates, it kills the process thereby freeing up all the memory and processor resources used by the DTO for use by other DTOs. Also, the Launcher monitors the execution of the processes and can kill hung processes if needed. In this way the transfers can run 24x7 for months on end without needing to reboot the computer to recover lost resources.

The launcher is run as a systems process, and will automatically start up again, in the event of power failure.

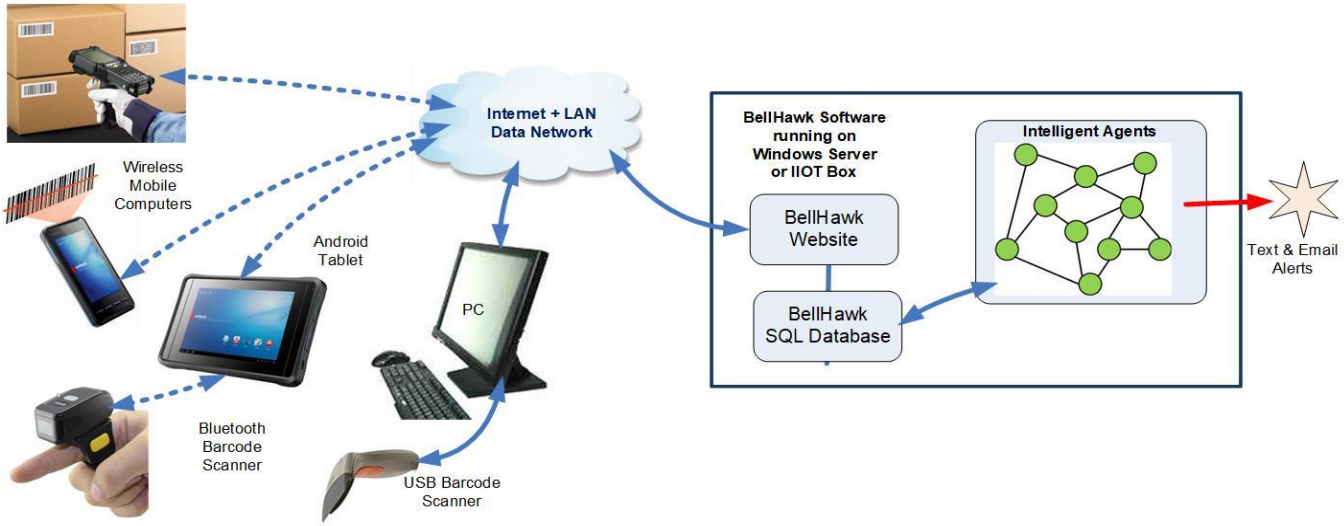
One biggest advantage of this architecture is that the Python Scripts can be replaced dynamically while the system is running just by uploading a new script through the MilramX user interface. Also Python Scripts can be dynamically added to the system and maintained by different user groups for their own purposes.

How KnarrTek Technology can be used to Improve ERP Systems



1. By replacing the use of the built-in MRP algorithms with the automatic generation of purchase orders, work orders, pick orders, and ship orders as new customer orders arrive. This can save a large amount of staff time manually doing this by "intelligent grunt work" using Excel spread sheets.
2. By replacing the use of paper forms and manual keyboard data entry for production tracking with technologies such as barcode and RFID scanning
3. By tracking the receipt, put-away, consumption, production, picking, packing and shipping of containers of material and individually serialized items in real-time.
4. By dynamically scheduling production operations to ensure that customer orders get shipped on time.
5. By automatically alerting managers and their staff, when there are situations where they need to intervene.
6. By automatically exchanging data with supply-chain systems and with Engineering CAD systems.
7. The BellHawk software can use the latest LPN and GS1 methods to track each container of materials and/or serialized items. It can also track pallets containing many different materials.
8. The MilramX software can automatically move data between systems, thus avoiding duplicate data entry,
9. Because the Intelligent Agents run autonomously to carry out their tasks there is no need for training in how to fill-out complex data entry screens. Also, operations data entry training is minimized through the use of technologies such as barcode scanning.
10. Through the use of user configured expert systems rules and Python scripts these systems can dynamically evolve as the needs of the business grow.

BellHawk Alerting Module



With the optional Alerting Module, which uses MilramX intelligent agents, the BellHawk Job and Materials Tracking software has the ability to monitor the BellHawk database and send Text or Email messages to managers and their staff when situations arise that they need to pay attention to.

Examples include:

1. Withdrawal of material from inventory takes inventory level of critical part below minimum required level. Typically sent to materials manager responsible for reordering.
2. Sending notification to customer when their order ships.
3. Alerting production manager if the time taken for a production operation exceeds that allocated for the job by more than a specified percentage.
4. Notifying engineering or production that a critical part has arrived on the receiving dock.
5. Notifying the quality control manager when a set of parts are ready for inspection.
6. Notifying maintenance if a piece of equipment is down and needs fixing.

Alerts can also preemptively warn managers about situations before they become major problems. They also save:

1. Time spent wading through reports to find out what went wrong yesterday.
2. Time spent in “coordination” meetings to try to discover what is going wrong in time to hopefully fix it
3. “Walking the floor” looking for problems that are about to arise.

4. Endless hours spent looking at screens in multiple systems to try to head off problems before they occur.

In BellHawk, alerts can be scripted to meet the individual need of each organization and avoid "spamming" the users of BellHawk with too many useless messages. Also, messages can be sent to lists of different staff and users depending on the severity of the issue detected by BellHawk.

Implementation

Upgrading an existing ERP system is a collaborative team effort between the client's staff and the staff at KnarrTek. Projects typically goes through the following steps:

1. Systems Design – to document what improvements are to be made. These improvements are usually done in a sequence of phases. Usually also results in an estimated schedule and budget.

2. Tracking System Pilot – set up a test copy of BellHawk on a Cloud-based server run by KnarrTek. Configure and test the system until it meet's the client's needs. This includes training operations managers and their staff, as well as materials handlers, operators, and other production staff to use the system and, if needed to incorporate suggestions for customizations.

3. Working jointly with the client's IT staff or with external consultants responsible for supporting the client's ERP system use MilramX to implement automated data exchange between the client's ERP system and BellHawk. Typically the client's staff or consultants provide the expertise for setting up the database Adaptors and members of the KnarrTek team write the data transfer scripts. These can, however, equally well be written by the client's own technical staff.

4. Working with the operations staff, develop Alert scripts specific to the client's business and any custom reports that may be needed. Again, this service can be provided by the staff of KnarrTek or these scripts can be developed by the client's own technical staff or consultants.

5. If needed, implement an automated customer order management system. This is typically done by KnarrTek staff who are experts in these systems.

Commentary

The above applies whether you decide to purchase a new ERP system or continue to use an existing ERP system. Two questions to ask, however, before buying a new ERP system:

1. Can we achieve the same capabilities at much lower cost by adding in some AI based capabilities, as described above, to our existing ERP system?

2. Can we simply purchase an accounting system, at much lower cost, and rely on the BellHawk, MilramX, and ICOM to software to provide the operations tracking and management we need, again at much lower cost, than buying a new ERP system?

For more information, please Email sales@KnarrTek.com and see www.KnarrTek,com.

Author

This white paper was written by Dr. Peter Green, who serves as the Technical Director of KnarrTek Inc. 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 Inventory Tracking and Operations 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 BellHawk materials tracking software and MilramX real-time artificial intelligence software platform.

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

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